1-41 No. 1-A

For
Applied Forestry Notes

Germination from Seed in the Duff in Western White Pine Stands.

by J. A. Larsen, Forest Examiner.

The results of studies in germination from seed of western white pine in the duff were given in a progress report from Priest River Experiment Station in June. This report includes studies in old B-3 and in younger B-2 white pine stands on the Kaniksu Forest.

In B-3 stand six different half acre plots were established after clear cutting. The slash was disposed of in different ways (See table.) Each half acre plot was sub-divided into 20-foot squares to facilitate counting and mapping . Each seedling was mapped so as to show its relation to original trees before cutting and to surfaces, whether burned or not. The timber was cut summer 1918 and counts taken 1919 and 1920.

Plot	Slash Disposal	White Pine Seedlings			Total	W.P. Trees before cut.	Seedlings per tree
		Unburned surface	Light burn	Hard Burn			
1	Broadcast spring	382	16.6	0	398.6	5	80
1a	Piled & burned	288	0	0	288	6	48
2a	Broadcast burn fall	28	0	0	28	1	28
4a	Winter burning 1919-21	5	0	0	5°	3	1.6
2	unpiled, spring burn	302	54	0	355	5	71
3a	spring broadcast burn	115	17	0	132	2	57
Average		274	17.5	0	241.5	4	57

° Count only one season 1920.

To date most of the germination has taken place on the unburned ground, none on hard burn and a few on lightly burned surface. The germination is localized by the old trees and by squirrel caches; to a minor extent according to where the trees fell in logging, 1918 being a good seed year for w. pine. From the above it appears that germination of white pine does not supply sufficient seedlings for a stand.

Much more encouraging are the results from a study in 150-year B-2 stand at Bryant Creek. On August 27, 1918 two five-acre plots were surveyed the timber tallied and samples of duff obtained for analysis of seed. The average of the stand shows the following trees per acre: W.P. 45, W.L. 20, D.F. 30, W.R.C. 135, W.F. 50 and W.H. 6. The seed recovered from the duff samples showed that there were present in the duff from 124,000 to 261,000 of white pine per acre and great quantities of the other species as well. In the greenhouse where this seed was tested the following winter the germination showed that there would be 5,436 W.P. per acre, in this stand, no white fir, spruce or hemlock and 11,292 of cedar and 4,847 of larch. By reducing these figures by 28 percent in order to obtain better average for field germination we still have 1,522 seedlings of white pine per acre. As a matter of fact an actual count taken on this sale area in 1920, three years after logging, but not on the exact placeewhere the plots where the seed had been collected, showed that there were 2,240 white pine seedlings per acre, 516 of larch, 6 of cedar and none of Douglas fir.

(For further data on the amount of germination from seed in duff on sale areas please see report by W. C. Lowdermilk and J. A. Larsen of Reproduction after Logging in Western White Pine Stands.)

5.436

No.1-B

APPLIED FORESTRY NOTES

D-1
1920

NOT FOR PUBLICATION

MARKING.

Marking is the most important step in the practice of silviculture. It is putting into use on the ground of all knowledge gleaned in the past from our studies of our forests and their component species. It is calling into play the fruit of our new experience in the woods. Its results are far reaching. On it depends the nature of the future stand, - that is, if a fire does not, in one fell swoop, burn over the area. But this possibility which with increased protective measures becomes more and more remote, should not at all affect the thoroughness of this operation. Marking is practicing what we foresters preach.

Marking calls into play the knowledge of the various species making up the stands. There is much to know about each species; - as to its frequency and quantity of seed production; its demands for seed germination and seedling survival; its demands on soil and atmospheric moisture; its demands on light, as a seedling, sapling and tree; its rate of growth; its root system; its susceptibility to diseases. But the knowledge of the individual species is not enough. Its interrelation with other species must be known, - how it grows and thrives in mixtures. Nor is that enough. The marker is concerned with what is beneath the forest floor as well as what is above it. A proper value must be given to the soil, its depth moisture content, and the subsoil beneath it. And further a proper weighing of the effects of winds, - and to what extent the relief of the region affects their force and direction. In short, marking presupposes a knowledge of trees discovered through investigations at the forest experiment stations, through the experiences of others and through close observation in the field.

Marking is difficult, that is, good marking is. It is a correct summation of all the factors that are operative in a given stand. These factors do not remain constant in their interrelation. A progressive summation, then is required. As tthe slope changes or the aspect is followed from east to west or from north to south, so the problem is a continuous one.

To remain perceptive of the varying phases of a stand through the day requires close attention. Many men prefer to mark alone, others like to mark with some one in order to be able to discuss the problems which arise. And if in the latter part of a hot afternoon where the slope is steep the marker continues to work out the local silvicultural problems as they arise, then he is a forester, a forester at heart, a forester indeed. It matters not what his degrees, or whether he has acquired his silvical knowledge amidst the four walls of a university, or whether he has acquired it in the woods and in his reading, he qualifies as a forester.

Important as this phase of silviculture is, it is not all. It is necessary to follow up the marking during the cutting of the stand. The sawyers must not be permitted to undo with a few swings of the ax and a few strokes of the saw what the marker has so studiously done. This is important. In fact the marker should follow the progress of the saws closely and make any corrections in his marking that show up to be necessary. This can only be done while the saws are on the area. And finally the marker should go over the area after logging to see in how far the stand appears as he planned in his marking that it should. A good job of marking is as evident in its results as is a well constructed house.

Marking is a science and becomes an art. Without skillful marking there is no practice of silviculture.

W.C.L.

1-C

No.1

RS
-1.

APPLIED FORESTRY NOTES.

(Not for publication).

December
1920

Effect of Cutting on Site Factors.

During July and August 1919 three weather stations were established near the Priest River Experiment Station to observe the physical differences in site within the uncut virgin stand, the partially cut stand and the clean cut area. Each of these three stations was equipped with maximum and minimum air thermometers, air and soil thermographs, evaporimeters and psychrometers. And at each station soil moisture samples and soil temperature readings were taken at 6-inch depths twice each week. The instruments were placed within substantial wood boxes of identical construction open to the north.

The following table shows the comparative conditions at the three stations:

Comparative Readings for Three Stations.

Site	Air Temperature		Relative Humidity 5p.m. %	Daily Evaporation C.C.	Soil Temperature Degrees F.	Soil Moisture %
	Av.Max.	Av.Min.				
250 year old uncut stand	80.3	46.2	35.0	16.0	54.7	28.0 Julyy 32.6 August.
1/3 Cover	85.3	44.3	33.0	26.9	59.9	23.5 July 28.1 August.
Clean Cut Area	87.7	39.5	30.7	35.3	63.2	31.6 July. 36.7 August.

The thermograph curve attached sets forth graphically the differences in air temperatures. In the forest the air is about ten degrees warmer than in the open at night, and about ten degrees cooler during the hot part of the day. These curves cross at 7:30 a.m. and 7:30 p.m. for July and August.

Soil temperatures further show the influence of the forest cover. In the clear cut area the soil temperatures fluctuate 4 and 5 degrees F. between maxima and minima. But within the forest there is a fluctuation of only one degree.

Another striking thing shown by the experiment is that the temperature of the soil in the open reaches the highest point between 12 and 2 o'clock at night, and the lowest point at 2 o'clock in the afternoon. The highest soil temperatures in the forest, on the other hand, occurred at about 4 o'clock in the morning.

J. A. LARSEN.

No. 1-D

RS
M

"APPLIED FORESTRY NOTES."

D-1
1920

(NOT FOR PUBLICATION.)

Does Western Larch Recover?

Recently a question arose in marking a stand in the Western White Pine type consisting of Western White Pine, Western Larch and scattered Douglas Fir classified as A2. The stand is even-aged, 110-120 years old and dense, so much so that growth is very slow now. Even the Dominant trees are growing rather slowly as shown by numerous increment borings.

By cutting out the trees above 14" d.b.h. a stand of 100 to 150 trees per acre would be left. But an elastic limit was used to conform to local silvical demands. Among such trees left are numerous Western White Pine and Western Larch 6-14 d.b.h. of even age with the dominant 20"-22" trees. Increment borings indicate that the smaller trees have taken 35-50 years to grow the last inch. Their form is slender, their crowns narrow, but they are still alive. They are classified as intermediate or suppressed as to crowns.

The question arose whether the Western White Pine and Western Larch trees left would recover and would make increased growth for a second cutting. It is the concesus of opinion that Western White Pine will, but the definite evidence on the Coeur d'Alene was burned up in the Jockey fire. But no one so far questioned seems able to state that Western Larch will recover.

It is desired, therefore, to secure definite data on the recovery of these two species or information where such data may be secured. A memorandum containing such information through the Supervisor to R. S. of the District Office would be appreciated.

W.C.L.

No. 2

RS
Working
Plans

APPLIED FORESTRY NOTES

D-1
1920

(NOT FOR PUBLICATION)

Volume Reserves in Forest Management.

Volume Reserve, as used in Forest Working Plans, refers to a volume of timber greater than the volume of the so-called normal forest held to care for unforseen contingencies. "Normal forest," however, is used in rather a liberal sense as applicable to Forestry in the Northwest. For under present conditions normality is an unknown quantity. A normal area distribution of age classes on the other hand is mathematically possible. And if such normal areas are credited with volumes which are actually found on the forest area in question, taking into consideration broad site classifications, an approach to the volume of normality is possible. And it is this meaning of the term "normality" that is used here. The reserve, then is considered as a certain percentage of this "normal" volume.

The business of Forest Management can not be reduced to exact calculations as is evident to those engaged in such work. So many contingencies arise to make incorrect any mathematical calculation. The reserve, then, is designed to make "surety" doubly sure by making provision for unforseen irregularities in the life of a stand.

Such a reserve would provide for losses by fire up to the percentage fixed upon. For example; a community dependent upon a certain forest area for a given annual cut would be assured of the continuation of that cut up to the destruction of, say 20% of the forest by fire or by other destructive agencies.

The market demands for timber fluctuate as do those of any other utility. Sound business principles should look to a provision for meeting such unusual demands. At times of heavy buying prices rise as now obtain. A considerable reserve in National Forests which could be sold under such conditions would tend to stabilize the market, in not generally, at least locally. In such wise a service to the public would be rendered.

The presence of a reserve is furthermore a safeguard against mistakes in the calculations of increment, which under present conditions are difficult to make applicable to wide regions of forest area.

A reserve, then, is implied in sound Forest Management.

Generally speaking there are two kinds of reserve; namely, area and volume. The area reserve is necessarily fixed and is unwieldly, and is not applicable to the Northwestern Forests. Volume reserves may be of two kinds; one fixed in a certain locality which partakes of the nature of an area reserve; the other the "flying reserve" is one of volume only. The "flying volume reserve" may be stored up in any part of or over the entire forest and is applicable to this region!

The methods of application of the flying reserve imply that a certain percentage be fixed upon, which local conditions must determine. Twenty percent is a figure which under average circumstances will meet the needs. This percentage is to be applied not to the present volume on the area but to what has been indicated above as a normal stand.

The method of building up the reserve is not here specified; for it is left to the working plans officer to work this out for his particular case. But it will imply the fixing upon a certain number of years in which the reserve is to be built up, for example, the entire rotation, a half or quarter of the rotation, which ever appears to be most expedient. The Austrian method indicates a simple formula method by which the object may be attained. At any rate the calculation would include a reduction of the annual cut below the annual growth by a certain amount until the desired reserve had accumulated.

The building up of a reserve is sound Forestry and sound business.

W.C.L.

37

No. 3

APPLIED FORESTRY NOTES

(NOT FOR PUBLICATION)

S
Supervision.

HELENA, MONT.
FEB 7 192
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January
1921.

Weed Eradication.

(Contribution from Savenac Nursery.)

Is it possible to save hundreds of dollars of labor costs in weeding seedbeds of coniferous seedlings? Experimental work at Savenac leads us to believe that it is possible and can be made practical.

It happened this way. In applying chemical treatment to the soil for the purpose of controlling damping-off, the absence of weeds was noticed. Chemical weed eradication has been studied in this country and abroad, but the work has been largely confined to the killing of plants which have attained considerable size. The possibility of practical soil treatments at the time of sowing seemed evident, because it is plausible that weaker solutions would suffice to kill weeds at the time they first break through and emerge from the seed coat. Strong solutions are more deadly, but must be ruled out because they are injurious to the pine stock being produced.

Very well; the next question is to find a cheap, effective, and safe chemical, and determine the proper amount to be applied per unit of seed bed area. Careful work on one hundred small plots during 1919 and 1920 was done with various strengths of copper sulphate, sinz chloride, and zinc sulphate. Lots of 200 seed each of the three most troublesome weeds at Savenac, -- clover, sorrel, and timothy, were sown in sterilized soil in each plot, together with 200 seeds of western white pine. Chemicals were applied to the soil at the time of sowing. Check plots, sterilized and non-sterilized, were left without treatment. Results were gaged by comparative germination (amount, time, and kind), examination of pine root tips to determine extent of injury, general thrift, etc.

Treatment with eight grams zinc sulphate in a liter of water per square foot of seed bed was chosen as most advantageous.

It succeeded in preventing practically all weed growth for two seasons after treatment, tended to stimulate first year germination of western white and western yellow pine, and apparently did so without appreciable injury to the stock.

Further work is planned. Two seasons is not a long enough period upon which to base conclusions. The next step will be to determine the effect this treatment may have on the growth of green fertilizer crops used at Savenac. If no difficulty is experienced in this connection, it would seem safe to recommend application on a commercial scale. Stock which has undergone this treatment will be followed at least three years after being set in actual field plantations, in order to observe the effects of possible internal injuries not now discernable. Complete results on this project are not expected before 1926.

W. G. WAHLENBERG.

No. 4

APPLIED FORESTRY NOTES

RS-D-1 (Not for Publication) February 1921.
Ts. W.W.P.
Accelerated
growth after
cutting.

Accelerated Growth
of
Western White Pine
after
Cutting

Sec. 3 Steamboat Creek - Coeur d'Alene N.F.

The following table and graphs show the result of borings taken on 40 trees ranging in diameter breast high from 3 to 14 inches. A very distinct acceleration in growth is noticeable. The trees from which borings were taken, were located in the strip taken for reproduction data, and on the top of a flat some 100 feet above the stream bottom. The exposure is generally south west and the site between II and III for W. W.P.

In the table it will be noted that for the diameter classes 3, 4 and 5 the growth for the last inch before cutting no growth percent is given. It was impracticable to secure satisfactory measurements of the rings, but the ages at breast high are given.

The original stand was a mixture of W.W.P.,D.F. and L. W.F. and was a partial selection type, in which W.W.P. Seedlings got a start in openings. The evidence is that such white pine advance growth grew slowly, in some instances very slowly until the stand was opened out by cutting.

A noticeable relation between height growth recovery and diameter recovery is shown in comparing the boring records with the notes on each tree as taken in the filed. For the larger diameters the recovery is not so noticeable since these trees were intermediate or codominant in the stand.

For this type of white pine stands it is definitely shown that white pine does recover and at a marked increase in i rowth percent.

The following is a table of
Heights on D.B.H. of the
40 trees examined.
Curved.

D. B. H.	Height in Feet
3	15.0
4	20.0
5	24.5
6	29.5
7	34.5
8	39.5
9	44.5
10	49.5
11	54.0
12	59.0
13	64.0
14	69.0

The following note refers to tabulation on the following page:

Note: The ratio between the first two average percents 2.55 and 3.09 is greater than if the percent of the "last 10 rings" were averaged for diameters 6 to 14 inches. In this case the percentage would be 2.63 instead of 3.09.

No.5

APPLIED FORESTRY NOTES.
(Not for Publication)

RS - D-1
TS - WL
Accelerated
growth.

February, 1921.

Memorandum for R.S. District Office
thru
Forest Supervisor, Flathead National Forest

The Recovery of Western Larch

From increment borings taken of western larch on cut over areas, I find that this species does recover from suppression and responds readily to thinnings.

The areas to which I refer are located near Trego, Montana on the Blackfeet National Forest. In this region, logging has been in progress since 1906 and many opportunities are offered to study the increased growth of larch after the removal of the merchantable stand.

In the case of nearly every tree bored on cut over land there was a distinct increase in growth shown the year after the cutting took place. In many instances the cores showed that at different periods during the life of the trees there were sudden and large increases in diameter growth. This increased growth would be maintained for from 10 to 20 years and then gradually grow less and less, until the annual rings could scarcely be discerned. Then later on there would appear another period of increased growth, similar to the former. This same process of irregular periodic increases was in evidence on many of the stumps which I examined. In several cases the increase was as much as from 60 rings per inch to 8 rings per inch.

It appears that this accelerated growth was due, more to thinnings by fore or insects, than to climatic conditions, as trees on different parts of the same section showed increases growth at different dates, i.e., one tree would show increased growth 20 years ago, another 35 years ago, others 50 years ago, etc. If this were due to climatic conditions all trees in one region would be affected the same.

TABELE - ACCELERATED GROWTH OF WESTERN LARCH.

DBH Class	Age	No. rings in last inch before accelerated growth	Growth % $\frac{400}{ND}$	No. of rings in first inch accelerated growth	Growth $\frac{400}{ND}$	Location Flathead National Forest
	WESTERN LARCH					
6.4	100	45	1.39	8	7.8	NE SE Sec.32, T.35W, R.25W
8.0	150	30	1.66	11	4.5	SW NE Sec.7, T.34N, R.25W
9.6	115	35	1.21	8	5.2	NE SE Sec.32, T.35W, R.25W
10.5	135	41	.929	10.0	3.8	Sec.6 Lot 7, T.34N, R.25W
11.8	160	44	.712	15.5	2.2	" 6 " 7, T.34N
12.2	175	35	.76	14.0	2.4	" 6 " 7, T.34N
	DOUGLAS FIR					
9.8	160	22	1.85	9.1.	4.5	SW NE Sec.7, T.34N, R.25W
10.7	133	43	.87	10.0	3.7	" " " " "

The figures given above are not exceptional cases but represent what I considered, at the time the borings were made, typical examples of accelerated growth after thinning western larch.

J. D. WARNER, Forest Supervisor,

By Remington Ellis Acting.

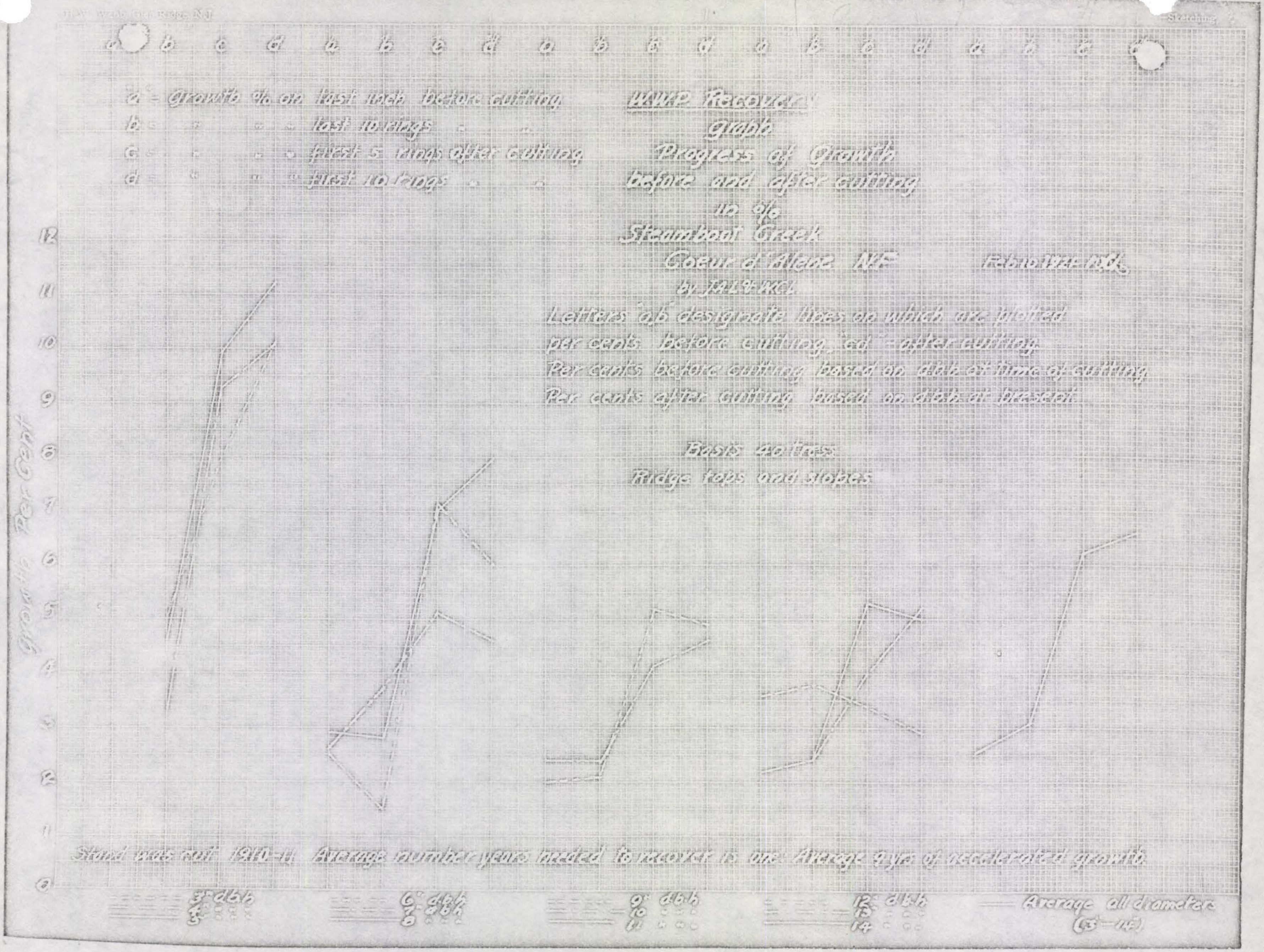
RECOVERY IN GROWTH OF W. W. P. AFTER CUTTING

		Before Cutting						After Cutting						
								First 5 years			First 10 years			
DBH Class	Age at DBH	No yrs. of accell growth	No rings in last inch	% 400/ND	Last 10 rings width in inches	rate yrs to grow 1 inch	% 400/ND	Width in inches	Rate to grow 1 inch	% 450/ND	width in inches	Rate yrs. to grow 1 inch	% 450/ND	Basis Number Trees
3	48	9.5			.37	27.	5.0	.26	18.8	8.0	.675	14.6	10.1	2
4	52	7.2			.219	45	3.3	.41	12.1	9.3	.90	11	10.1	5
5		10.			.437	23	4.6	.55	9.1	9.9	1.25	8	11.2	2
6		9.	31	2.5	.20	50	1.5	.48	10.5	7.1	.80	12.5	6.0	3
7		10	24	2.6	.57	17	3.7	.40	12.5	5.1	.70	14.0	4.6	2
8		10	20	2.9	.475	21	2.8	.62	8.0	7.0	1.29	7.2	7.9	4
9		9	25	2.0	.416	24	2.1	.525	9.5	5.2	1.02	9.8	4.9	5
10		8.5	20.6	2.4	;47	21	2.4	.916	10.9	4.15	1.03	9.7	4.6	9
12		9	11	3.6	.95	10.5	3.8	.456	11	3.4	.77	13	2.9	4
13		7	18	2.2	.60	16.5	2.4	1.15	8.7	4.0	1.50	6.6	5.2	1
14		9.3	16	2.2	.65	15	2.4	.825	6	5.3	1.52	6.6	5.0	3
Average		8.9		2.55			3.09			6.22			6.6	

The growth percents before cutting are calcalated on diameters at time of cutting, those after cutting on present diameters.

Steamboat Creek, Coeur d'Alene National Forest
by J.A.L. and W.C.L.

(Note referring to tabulation is on preceding page.)



a = Growth % on last inch before cutting
b = " " " " last 10 rings " "
c = " " " " first 5 rings after cutting
d = " " " " first 10 rings " "

WWP Recovery
graph
Progress of Growth
before and after cutting
in %
Steamboat Creek
Coeur d'Alene N.F.

Feb 10 1922 R.K.L.

by J.A.L. & R.K.L.

Letters "a,b" designate lines on which are plotted
per cents before cutting, "c,d" - after cutting.
Per cents before cutting based on d.b.h at time of cutting
Per cents after cutting based on d.b.h at present

Basis 40 trees
Ridge tops and slopes

Stand was cut 1910-11. Average number years needed to recover is one. Average 9 yrs of accelerated growth.

F D-1
Pf

9K

February
1921

FOREST SERVICE
KANIKSU NATIONAL FOREST,
NEWPORT, WASH.
MAR 1 1921
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APPLIED FORESTRY NOTES

(Not for publication.)

No. 6

RELATIVE HUMIDITY OF THE ATMOSPHERE AND ITS RELATION TO THE FIRE PROBLEM.

By J. A. Larsen

It is known that the warm air is able to hold as vapor more moisture than cold air and that this moisture leaves the air in form of dew, fog or rain whenever the air cools below a certain temperature. During the heat of the day the relative humidity is therefore much less than at night. Fires burn more briskly during the heat of the day not only because there is more heat and atmospheric circulation but also because there is less moisture in the dead needles and twigs at this time. This is shown in the following table:

Fluctuations in Moisture Content
of Dead Pine Needles According to the
Relative Humidity of the Atmosphere
Priest River Forest Experiment Station.

Hour	8 A.M.	10 A.M.	2 P.M.	4 P.M.	6 P.M.
Atmospheric Humidity	82	66	41	34	61
Moisture Content of Duff	10.3	10.2	9.2	6.1	7.2
%					

The table shows that the needles are dryest at 4 P.M. at the time of the highest air temperature and greatest wind movement. We have therefore three powerful factors working together to produce critical conditions for fires. It should be stated that the tests have shown that the dead needles do not burn freely with a flame when the moisture content is greater than ten or twelve per cent.

The following table shows more fully how the relative humidity varies by day and by night:

Hourly Relative Humidity
(Hygrograph %)

Sheridan, Wyo. July 1913 - April 1916.	A.M. 2	4	6	8	10	Noon	P.M. 2	4	6	8	10	12
May	80		82	67	56	50		48	50	64	73	77
June	83		82	63	53	48		48	53	65	76	81
July	74		78	58	47	44		39	43	53	68	71
Aug.	72		82	62	43	34		33	38	55	65	71
Sept.	81	83		70	50	41		41	49	67	75	80
Priest River, Idaho. July 1918				55	44	35	29	28				
Boise, Idaho.												
May	64	68		64	53	44	38			44	51	58
June	61	66		62	53	44	39	35		41	49	57
July	49	55		53	42	34	29	26		29	35	43
Aug.	46	51		52	40	32	26	22		27	32	40
Sept.	48	53	56		46	37	31		28	34	40	44

It goes without saying that there is less relative humidity in the atmosphere during the warmest summer months than in fall or spring. Data on this relation are given in the following table:

Table 3.--Mean Relative Humidity
District 1. (5-6 P.M.)

Station	Record	April	May	June	July	Aug.	Sept.	Av.
		0/0	0/0	0/0	0/0	0/0	0/0	0/0
Spokane	1890-1910 8 P.M.	39	38	33	25	25	35	32.5
Priest River	SW slope 5 yrs. to 1916	51.9	52.8	50.8	46.5	38.9	66.2	52.5
Kalispell	(11 years (to 1916	49	49	47	37	36	50	44.7
Helena	21 yrs.	42	42	41	31	30	39	37.6
Havre	15 yrs.	44	45	43	35	34	44	41.2
Miles City	10 yrs.	56	51	51	42	42	52	49.0
Yellowstone Park	10 years to 1919	54	51	41	38.5	36	48	44.7

The average relative humidity for Spokane during July an and August is 25 per cent, but from 36 to 38.5 per cent at Yellowstone Park and from 30 to 31 per cent at Helena. This evidently g[illegible] long ways toward explaining the more serious fire situation in Idaho than in to the east of the Continental Divide.

Yellowstone Park lies much higher than Spokane or Helena, to be sure, and for this reason we should expect a moister atmospheric condition at Yellowstone; but the differences are due mainly to somewhat greater precipitation during July and August east of the Divide and because Spokane and Idaho are more exposed to the dessicating winds coming from the dry region to the west over which the air is much heated in summer.

Considerable difference in the relative humidity of the atmosphere is found for different elevations; higher points show more relative moisture by day and less by night than low stations. Data showing this are given in the following table:

Relative Humidity on Mountain and in the Valley near
Priest River Experiment Station.

	July		August		September	
Hour	Mtn.	Valley	Mtn.	Valley	Mtn.	Valley
8 A.M.	---	---	60	73	71	87
1 P.M.	70	32	49	26	62	47
5 P.M.	65	34	46	32	56	57

These conditions come about because the air temperature on the mountain is lower by day than in the valley and higher at night on the mountain than in the valley and because there is much more air movement at night on the mountain than in the valley. This explains why the fires burn so much more readily at higher elevations at night while they are less active in the valley or on the flats.

Somewhat similar conditions operate on the different aspects in that the air temperature on the northeast slope during July and August is about ten degrees lower in the afternoon than on the southwest aspect. However, since the air movement on the northeast aspect is only about one third as much as on the southwest the fire hazard is materially reduced on northerly slopes. The differences in relative humidity for different aspects for August and for the entire summer at the Experiment Station are given in the following table:

	NE Slope	SW Slope	Flat
Aug[illegible]	47.1	38.9	44.1
May-Sept.	56.3	49.2	52.1

It has been found that the relative amount of water vapor in the air affects visibility to a very marked degree. The data set forth in the following table may not apply strictly to this territory but are of considerable interest from a standpoint of efficiency of lookouts. (John Aitken, in Proc. Royal Soc, Edinb. v. 20, p. 548.)

Mean Limit of Visibility in Miles Falkirk, Eng.

	Depression of the wet bulb, degrees F.						
	2	3	4	5	6	7	8
Visibility	50	100	132	132	178	193	191

RS
Weather

APPLIED FORESTRY NOTES

II-1
March-1921

(Not for publication.)

No. 7

Wind and its Relation to Forest Fires

by

J. A. Larsen

From the standpoint of forest fires the air movement functions as a drying, fanning and carrying agency. In considering air movement it is important to bring out the direction, force and variations which may exist for different parts of the District, for different seasons, months, time of day and under special conditions of weather elevation or topography. Table 1 gives average movement in miles per hour for the weather bureau control stations within or near to District One in miles per hour.

Table 1

Wind Movement District One - Average Miles per Hour.

Station	Record	April	May	June	July	Aug.	Sept.	Av.
Spokane	25 yrs.	6.9	6.7	6.8	5.9	5.3	5.4	6.2
Lewistown	1909 to 1919	4.9	4.2	4.6	4.5	3.7	3.5	4.2
Priest River 5 yrs.	SW slope to 1916	3.4	3.3	3.2	2.9	2.7	2.6	3.0
Kalispell	1909-19	5.4	5.4	4.4	4.9	4.4	4.2	4.8
Helena	19 yrs.	5.6	6.8	7.2	7.7	7.8	7.4	7.1
Havre	1911-19	7.5	8.9	7.8	6.9	6.2	6.7	7.3
Miles City	1909-19	7.1	6.8	6.3	5.7	5.1	5.2	6.0
Yellowstone Park	1909-19	8.0	8.2	7.6	6.5	6.7	7.2	7.4

It will be seen that during the months of July and August the movement is greater at Helena and Havre than at the other stations. The prevailing wind direction in summer over Washington and northern Idaho is from southwest and to the east of the Continental Divide it is from the northwest and southeast. Considerable variation and deflection takes place according to topography for the wind follows pronounced canyons, and takes advantage of gaps in a divide. The Joki fire on the Coeur d'Alene Forest 1919 followed the canyon of the Coeur d'Alene River. Complete maps showing the prevailing local wind direction for different parts of the District are not available, but each man knows fairly well the conditions for his own territory.

The velocity, and drying as well as the carrying effect of the wind will vary according to the height and direction of the mountain ridges. In the Clearwater drainage the air movement is in many cases parallel with the ridges so that the wind gets a freer sweep, whereas in the Panhandle of Idaho the ridges lie transversely to the prevailing wind and thereby break its force. The valleys are therefore less exposed and high winds there than if the ridges had an east and west trend.

Air movement on the peaks and lookouts has been shown to be considerably greater than at lower points. These are given in Table II.

TABLE 11.

Air Movement on Lookouts

Summer 1919

(Miles per hour, per day)

STATION ELEVATION FOREST	JUNE		JULY		AUGUST		SEPTEMBER		RECORD
	AVERAGE	MAXIMUM°	AVERAGE	MAXIMUM°	AVERAGE	MAXIMUM°	AVERAGE	MAXIMUM°	MISSING DATES
Sunset 6,424 Coeur d'Alene	8.8	12.1	9.6	15.9	10.2	14.9	12.6	21.5	June 1-15 Sept. 16-30
Mt. Silcox 6,840 Cabinet			11.7	21.2	12.5	24.7			None
Coolwater 6,930 Selway	8.9	19.9	8.2	12.7	8.1	10.2	9.9	16.2	& 26 June 1-16 Sept. 21-30
Monumental Buttes 6,979 St. Joe			13.0	28.6	15.0	29.6	15.5	27.5	July 1-7 Sept. 18-30
Priest River 6,000 Kaniksu			9.5	16.1	8.9	14.3	10.6	22.4	16,17 July 1, 2,- Aug. 5-12 Sept.20-30
Mount Silcox Cabinet 1917			13.0	13.8	11.5	23.1	12.4	21.6	July 1-12 Sept.20-30
Mount Silcox Cabinet 1918	14.7	20.2	12.7	26.7	?	20.0	14.3	31.0	June 1-17 Sept. 24-30

Note:-These do not represent the absolute maximum velocities that may occur.
°These figures represent the highest velocity recorded for any one day.

Lookout men who took records:
Priest River - W. Simmons
Monumental Buttes-Eugene Harpole
Sunset - Paul Wickward
Mt. Silcox - Jefferson C. McKeel 1918
L. F. Rosenthal 1919
Coolwater - Gerald J. Gill

Comparative records which show how the wind varies for different parts of the day at high and low points are given in Table III.

TABLE III

Wind on the Lookout and in the Valley Priest River Experiment Station, 1917.

Average Miles per Hour by Months.

Time of Day	July		August		September	
	Mtn.	Valley	Mtn.	Valley	Mtn.	Valley
5 PM-8AM	10.9	0.9	8.4	0.8	8.1	0.8
8 AM-1PM	9.9	3.6	7.9	3.1	3.0	2.5
1 PM-5PM	11.4	3.9	9.7	3.2	7.3	2.3

Table III brings out that the air in the valley is almost still at night and that on the mountain there is almost as much movement at night as during the day. This fact, when considered in connection with the lower relative humidity which was shown to prevail on the mountain at night, (Applied Forestry Notes, February), helps to explain why fires burn better at night at higher elevations than in the valley.

It is of considerable interest to note how the rate differs for different aspects. This is brought out in the records taken from 1911 to 1916 at Priest River Experiment Station in northern Idaho.

TABLE IV.

Greatest Air Movement for any One Month, Miles per Hour.

Month or Season	NE Slope	SW Slope	Flat
May	2.9	8.7	5.7
June	2.1	6.8	3.3
July	1.9	7.9	3.7
August	1.9	7.6	3.6
September	1.9	8.6	3.9

The hourly wind records which have been compiled at the Experiment Station show that the highest velocities are reached at 4 PM and the lowest from 4 to 5 AM during the summer months. The time of the highest movement coincides with the time of the highest air temperature and the lowest relative humidity.

Chinook winds reduce the layer of snow throughout the winter and frequently cause early disappearance of snow and this may bring on the fire season at an earlier date in the mountains than would otherwise be the case.

We have in mountainous country characteristic monsoons, sometimes referred to as air drainage, the air moves up the valley during the day and down the valley at night. In the evenin when the two currents meet toward the upper part of the valley it causes a bank of smoke about the time of sunset which interferes with the visibility to a marked degree. The following morning the air current from above has generally cleared the entire watershed of smoke. The downward movement begins earlier in the afternoon on the shaded than the sunny side of the mountain.

How did the wind act on the lookouts on or about August 19, 1919 at the time of the holocausts on the Clearwater and the Coeur d'Alene Forests? Not so very bad. Here are the records in miles per hour for the 18th and 19th.

Lookouts	August	
	18th	19th
Sunset	8.8	---
Monumental Buttes	18.3	6.8
Priest River	9.6	11.8
Coolwater	5.6	6.0
Mt. Silcox	9.0	---

Mr. G. A. Beals in the U. S. Monthly Weather Review, February 1914, points out that no unusual conditions which would cause extraordinary winds attended or preceded the worst fire on record on the Columbia Forest in the Cascades 1902. On the contrary the atmosphere had been comparatively still for three weeks previously. But - and hereby hangs a tale - the wind shifted to blow from the northeast the day before the fire. It then blew from the dry country lying between the Cascades and the Bitterroots. And, are we not exposed to the wind from this dry region most of the time in northern Idaho in summer?

The unusually high winds which accompany the large forest fires appear to be caused and set in motion by the flames themselves. Evidently the ascending currents of heated air and smoke make an opening through the upper, colder stratum of the air, not much unlike a tall chimney, and the strong surface winds which uproot trees are caused by the inrush of air to fill the vacant space left by the upward draft.

Nobody can foretell the speed or the force of this tornado-like sweep. At the time of the Hinckley fire one wagon which weighed a thousand pounds was lifted up and carried across a railroad track. Needless to say that it would be impossible for anybody to maintain a standing position. In this connection it is interesting to read again Mr. Girard's vivid description of what he experienced on the Clearwater Forest August 19, 1919, in the Weekly Bulletin of the Washington Office, September 22, 1919.

J. A. L[illegible]

No. 8

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April
1921

RS
Protection
Insects

Applied Forestry Notes

Not for Publication

No. 8

Status of Insect Infestations

Coeur d'Alene N. F.

By James C. Evenden
Specialist - Bureau of Entomology.

Research studies of the Coeur d'Alene Forest Insect Station, concerning Dendroctonus monticolae infestations in western white pine are being carried on in the Coeur d'Alene National Forest. The entire white pine type of this forest will be covered each year by a very extensive reconnaissance, to determine the character and extent of the general infestation. Research work will be conducted within a tract of 1500 A(°) of white pine type on the headwaters of Independence Creek. This area has been secured from the Forest Service for a period of five years to be used by the Bureau of Entomology as an experimental area. The location is well adapted to this study as it is practically surrounded by large burned areas, which gives an isolation from outside conditions and factors.

The points which will be covered in the research work are as follows:

1. To determine the importance from an economic viewpoint of the depredations by Dendroctonus beetles in the forests of Northern Idaho.

2. The cause, character, and period of time relative to the intermittent increase and decrease in the annual infestation.

3. Studies of seasonal history, conditions influencing rate of mortality, factors which induce beetles to attack certain individuals of their host species, flight habits, and the relation of forest fires to subsequent insect attack. These studies to be carried on in conjunction with Dr. Hopkins' investigation of the bioclimatic law. Investigations will also be made for possible and practical control measures.

4. To investigate secondary insects, and bark beetles of minor importance, with the character and extent of damage involved. Also the relation of these insects to the primary species.

(°) Forest Service Appraisal.

Besides the technical research work conducted on the Independence Creek Area, during the past season, a very intensive reconnaissance for total insect damage was made of the entire area, and all insect killed trees for the years 1918 and 1919 were marked, mapped and a record taken of each. The results of this survey are as follows:

During the past ten-years from 12 to 16 percent of the white pine timber has been killed by Dendroctonus monticolae. During the years 1913 and 1914 these losses were greatest. In 1915 the epidemic started to decrease and in 1917 had reached a stage which was within the normal balance of infestation. Later this infestation during the season of 1919 showed a very marked increase over that of the 1918 attack.

Year of Attack	Number of trees	Percent increase in numbers of trees	Volume b. f.	Percent increase in volume b. f.
1918	12		11,000	
1919	58	483%	40,000	363%

The figures for the 1920 attack will not be available until next season; however, from observations made of this season's attack, it is very evident that there will be a very substantial increase over the infestation resulting from the 1919 attack.
The losses resulting from the 1918 attack were approximately 3/10 of 1% of the white pine stand, while the 1919 damage was a trifle over 1%.

Though the figures secured from the Independence Creek area was to be used as a check over the entire white pine type, it was found that the damage in other parts of the forest was much lower. This may be due to the isolated condition of the Independence Creek area, which gives it a normal or natural condition, while in other parts of the forest there are many logging operations in progress, which tend to upset the natural cycle of infestation. In small areas remote from any recent logging operation, conditions were found to be about the same as in Independence Creek.

From the extensive reconnaissance made of the Coeur d'Alene National Forest, it is estimated that 3/10 of 1% of the white pine stand was destroyed by the attack of Dendroctonus monticolae, during the season of 1919. This investation covers the entire white pine type and consist of scattered trees or small groups of two or three, and in some few cases more. This percent of loss applied to the total white pine volume of the forest gives the following result:

White Pine volume Coeur d'Alene National Forest	percent of volume Killed season 1919	Volume killed
,500,000,000 board feet	3/10 of 1 percent	4,500,000 B.F.

It is very evident that the depredation in white pine by the mountain pine beetle, within the Coeur d'Alene National Forest, started to increase during the season of 1919. At the present time the situation is not alarming, and cam hardly be called more than a normal infestation, but as it is practically impossible to foretell the limits of the present rise of investation, it is very important that all existing depredations be promptly reported.

James C. Evenden
Specialist in Charge.

GK

Applied Forestry Notes

RS
Weather

Not for Publication

D-1 No 9
April
1921

Sunshine and Air Temperature
In Relation to Forest Fires

By J. A. Larsen

The sun is obviously the fundamental controlling factor of temperature changes by day and by seasons. Topography is a secondary factor, in that the actual amount of heat which reaches the surface depends also upon exposure, angle of slope elevation, density of the air and general topographic relations to mountain lakes, plains or forest land. The amount of heat absorbed by any surface depends also upon its composition, color and structure.

Table 1.-Sunshine--per cent of possible

District 1.

Station :	Record	April	May	June	July	Aug.	Sept.	Av.
Spokane	25 yrs.	60	58	67	67	74	64	65
Priest River	5 yrs. 1912-16	46	45	52	61	66	46	53
Kalispell	1909-19	55	51	59	70	69	59	60
Helena	1909-19	61	60	65	73	73	58	65
Havre	1909-19	59	56	64	71	67	58	63
Yellowstone Park	1909-19 exc.1917	57.4	53.6	63.6	69.9	72.6	58.3	63

The amount of sunshine that each station should receive is determined on the basis of its latitude. This is 100 per cent. Cloudiness brings the percentage down to 74 percent at Spokane, 73 percent at Helena, 69 percent at Kalispell in August. The actual current monthly amount of sunshine which is registered at these stations is published monthly in the U. S. Weather Summaries for Washington, Idaho and Montana.

It is of interest to note that the bad fire years registered more than normal amount of sunshine. Take for example Spokane and Helena:

Year-1919

Sunshine - Percent of Possible

	May	June	July	August
Spokane	72	88	89	81
Helena	61	61	71	80

Temperature conditions in summer over the District do not show very startling differences. In general the maxima are higher in Idaho and Southeast Montana than in the intermediate sections.

The following are mean August Air Temperatures:

North Idaho	Central Idaho	N. W. Montana	S. W. Montana	N. Central Montana	S. Central Montana	S. W. Montana
63.8	66.0	63.0	62.0	64.0	63.2	68.9

The temperature must be considered in relation to precipitation. This will be taken up in a separate paper.

More heat is received on south slopes by obstruction and reflection of the sun's rays. The actual measurements at Priest River Forest Experiment Station 1911-1916 show the following:

	Northeast slope; W. Pine	Southwest slope; D.F.-Yel.Pine	Flat Larch D.Fir
Mean Air Temperature			
Rest period °	33.0	34.4	32.4
Growth period °°	57.1	59.0	56.5
August	62.7	65.5	61.7
Year	45.8	47.5	45.1
Average Minimum			
Rest period	32.6	32.1	28.5
Growth period	39.8	39.2	35.4
August	48.6	47.6	41.8
January	17.0	16.8	11.0
Soil Temperature			
12 inch depth			
Rest period °	36.7	40.0	37.1
Growth period °°	52.8	59.0	57.3
August	56.8	65.0	62.5
January	33.8	34.1	33.0
Year	43.3	47.9	45.5

° October to April inclusive
°° May to September inclusive

In summer the flats and low country heat up much more in clear weather than broken topography or land at higher elevations. The reverse is true at night.

Temperature measurements for these relations are given below for the Priest River Experiment Station and nearby lookout:

(Averages for August 1919)

	A.M.						P.M.	Degrees F.				
Hour	2	4	6	8	10	Noon	2	4	6	8	10	12
Valley El.2300'	42.7	40.4	39.5	50.4	64.5	76.7	82.4	83.3	78.5	61.2	51.0	46.1
Lookout El.6000	54.4	52.8	54.6	58.2	61.3	64.3	67.2	65.7	61.2	57.7	56.5	55.3

There is, of course, the year round, more heat and less moisture at lower than at higher elevations. This is chiefly responsible for distribution of forest trees and types; yellow pine at lower levels and other non-moisture loving trees higher up.

These relations have been worked out to a degree on the Nezperce Forest by R. N. Cunningham, as follows:

	Yellow Pine	Lodgepole Pine	Sub-Alpine
Rainfall-year	15-25"	30"	45"(?)
June, July, Aug.	2.87"	5.42	7"(?)
Relative Hum. 8 A.M. July-Aug.	36	64	
Mean Max. Air Temp.	93	78	66
Absolute Max.	108	98	88
Percent of Fires over 10 acres	42	9	0
Average Size Class C (except 1910)	233A	17A	3/4A.
Average Size Class C Fires August	2500A	780A	50A.

The analysis is carried on to show date of first fires, average length of season and close of fire season.

It is possible for us to compare temperature records for stations of different elevations.

Station	Elevation	Season when mean Temperature is above 50° F °°
Orofino	1027	6 months
French Gulch	4000	3-1/3 "
Roosevelt	7000	2-1/2" "
Missoula	3225	5 months
Ovando	4050	3-1/3 "
Bowen	6080	2-1/2 "

°° Studies on the relation of climate and fires by C. C. Delavan and J. A. Larsen point to the conclusion that a mean temperature of 50°F and the period during which the rainfall falls below 2 inches per month limits the average fire season.

Of special interest in fire problems is the behavior of air temperature at the time of the really bad forest fires. In our District we are unfortunate in having as a fixed climatic feature the coincidence of the culmination of the driest and the hottest part of the year in August.

During certain years there occurs an uninterrupted succession of high pressure areas accompanied by clear hot weather. At such times the temperature climbs a little higher each day until something tears loose.

The following shows temperature conditions leading up to July 15, 1919, and to bad fires on the Kaniksu Forest:

Record for Priest River Forest Experiment Station

July 1919

Date : July	11	12	13	14	15	16	17
Maximum	84	77	85	92	98	98	69
Minimum	--	42	39	43	45	53	50
Relative Humidity	22	26	24	21	22	18	31

In the afternoon of the 15th and 16th the fires did much damage on the Kaniksu Forest but on the 17th the fires were not running. Similar rise in temperature from day to day and dro in relative humidity led up to unusually bad fires August 19, 191

UNITED STATES FOREST SERVICE

DISTRICT ONE

RS 92

APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1921 May No. 10

These "notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester: Attention RS, Missoula, Montana. W.C.L.

PURPOSE OF THE APPLIED FORESTRY NOTES:

The "Notes" are an organ of the District Investigative Man. Their object is to keep the field men informed of some of the more important results of research of the Forest Service and of the Bureaus of Pathology and Entomology in cooperation with the Forest Service. The list of standing active cooperators is -

J. A. Larsen, Priest River Experiment Station,
W. G. Wahlenberg, Planting Research, Savenac Nursery,
Dr. James R. Weir, Laboratory of Forest Pathology,
Spokane, Washington.
James C. Evenden, Specialist, Bureau of Entomology,
Coeur d'Alene, Idaho.

In addition, contributions from Forest Officers in the field are desired. From time to time special studies are made by field men of the rate of growth of stands, on marking, on the effects of different methods of slash disposal, on the costs of disposing of slash, for example, on the unit basis, and on many other problems. The results of such studies are especially desired. In other words, any established information which will be of use to other forest officers of the District is desired to fill the pages of these "notes." Contributions from the faculties of the State Forest Schools of Montana and Idaho are likewise desired.

At the same time such conclusions as are reached from time to time by the regular investigative force will be summarized in the "notes;" any comments on any of the issues and suggestions as to methods of greater usefulness to be used in the "notes" will [illegible] gladly received. Just send them to the District Forester, attention of RS.

W. C. Lowdermilk

Forest Examiner

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U. S. Forest Service

APPLIED FORESTRY NOTES

Silvical Investigations

District One

RS
P - Insects

May
1921
No.11

(Not for Publication)

FOREST INSECT CONTROL.

NEED FOR CAREFUL SURVEILLANCE OF WHITE PINE STANDS OF IDAHO AND MONTANA.

By James C. Evenden
Specialist Bureau of Entomology
In Cooperation with Forest Service

From observations in the Coeur d'Alene National Forest during the field season of 1920, it is very apparent that the insect depredations within the white pine stands by the Mountain Pine Beetle ° started to increase in this area with the 1919 attack. Our knowledge of past insect infestations in our Western forests, where serious damage resulted, show that the epidemic was not confined to small local areas but rather to large topographical units. In this connection it is useless to more than mention the broadcast destruction of white pine throughout Northern Idaho and Western Montana, as a result of the 1911, 1912, and 1913 attacks of this insect. With this knowledge it is assumed as a matter of safety, that the infestation throughout the entire white pine belt is increasing at this time. The limits of this increase are impossible to foresee. The infestation may be held in check by natural means of control, or there may be a recurrence of the 1911, 1912, and 1913 epidemic. In view of the possibilities of this condition it is very important that a careful check be kept upon all white pine stands in order to secure definite data on all local areas within this District. This knowledge is essential from the standpoint of controlling endemic infestations at a smaller cost with a greater saving, rather than epidemics with opposite results.

In order to secure this data it becomes necessary to depend a great deal upon the color changes of the tree foliage following the attack. It may be appropriate at this time to mention briefly the general seasonal history of the Mountain Pine Beetle,

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°° Dendroctonous monticolae.

in order that the foliage changes will be thoroughly understood. The beetles attack during July and August. The parent beetles construct the long perpendicular egg galleries within the cambium along which the eggs that soon hatch into the small grubs or larvae are deposited. The winter is passed with the insect in the larval stage, the transformation to the new adults taking place during June and July, and the emergence soon following. There is sometimes a late or partial second generation, which pass the winter as very young larvae or new adults. The transformation from the egg to the adult takes place entirely between the bark and the wood; this is contrary to the larval and pupal stages of the Western Pine Beetle ° which are passed in the middle layers of inner bark. Following the attack of white pine trees by Mountain Pine Beetles the foliage starts to fade the subsequent winter, followed by a yellowish appearance in April or May, and the distinctive red-tops in May, June, or July. The needles start falling the second winter after the attack and by the following summer very few remain. Therefore, a tree with fading, yellowish, or red foliage before the month of July contains the broods of this insect. A red top tree observed after July has been abandoned by the beetles and must be disregarded in all control projects.

If necessary to secure in one season a knowledge of the status of an insect infestation, a comparison must be made between the trees containing the broods and the ones killed the previous season. Or if a yearly check is being kept upon an area, and the yellow or red top trees counted and mapped each season, a very accurate knowledge of the increase or decrease of the infestation will be secured. As it is nearly impossible to count all of the infested trees from observation points these figures can be checked, if more accurate data is required from simple plots which can be intensively cruised and the correction factor obtained applied to the entire area.

The general information as given for the observing of Mountain Pine Beetle infestations in white pine, can be applied to those in lodgepole pine stands, also to the depredations in yellow pine by the Western Pine Beetle. In spotting forest insect infestations care must always be exercised not to consider the trees from which the insects have emerged. It is always well to make frequent examinations of the red top trees in order to check the conditions which are indicated by the color of the foliage. These rules are for general conditions and will no doubt require slight adjustment to meet regional conditions. Furthermore, they do not provide for the complicated case which is continually confronting the field worker, such as results from late or partial second generations, top killing of trees followed the subsequent season by a basal attack, or the combined attack of two or more species. These and many other cases are always more or less confusing, but must be considered abnormal and of no great importance in the general problem of forest insect control.

° Dendroctonus brevicomis.

The Forest Insect Field Station, at Coeur d'Alene, Idaho, will be very glad to furnish to any Forest Officer, or timber owner, any information that is possible for us to give, which will be of assistance toward a successful solution of their problems. The Station will also appreciate information as to the location, present status, extent, etc., of infestations within the District.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

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RS

APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1921 May No. 12

These "notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

Seed

The knowledge of the seed producing characteristics of our various species is not yet complete. The following table is a compilation of present available information on seed, for the several species. Some of the columns are incomplete and especial attention is directed to "Month Seed are Ripe," "Youngest Cone Bearing Age" and "Years of Heavy Seed Crops in the Past." Any information which will fill out these columns is desired.

It is especially desired to secure data on the amount and viability of seed produced in cones on very young trees and the ages of such trees. Field men are requested to forward cones found on young trees about the latter part of August or first of September to the Priest River Experiment Station for testing. The cones should be placed in small sacks, by species separately. Notes on the age, location, exposure and description of surrounding stand should be included. Any information which will assist in the revision of this seed table is desired.

W.C.L.

RS

D-1 1921

SEED TABLE BY SPECIES
(Subject to revision)

Species	Number seeds per lb.	Production per tree in lbs. by D.B.H. classes.				Years to mature	Nursery germination %	Month seed are ripe	Month seed are shed	Youngest cone bearing age in open	Youngest cone bearing age in stand	Periodically years	Years of heavy seed crop in past
		0-8	8-16	16-24	24°								
WWP	24-31,000	-	1/8°	1/5	¼°	2	60	Aug.	Sept	15-20	?	3-4	11-14-15-17-20
WYP	10,000	-	-	-	-	2	50-60	Aug.	Sept	--	-	3-4	11-15-20
LPP	115,000	-	-	1/50	-	2	50	Aug.	Sept	-	-	7-10	?
LP	?	-	-	-	-	2	-	-	-	-	-	-	-
WL	110,000	-	-	-	-	1	60	Aug.	Sept	30	-	5-6	20
DF	40,000	-	-	-	-	1	50	mid Aug.	early Sept	-	-	1	-
ES	190,000°°	-	-	-	-	1	50	Aug.	Sept	30?	-	3-4	20
WRC	320,000°°	-	-	-	-	1	50-60	Aug.	Sept	-	-	3-4	15-17
WH	465,000	-	-	-	-	1	65	Aug.	Sept	-	-	1 (?)	?
LWF	20,000	-	-	-	-	1	?	Aug.	Sept	-	-	-	15-20
AF	?	-	-	-	-	1	?	?	?	-	-	-	-
Juniper	?	-	-	-	-	2	?	?	?	-	-	-	- 20

Compiled by W.C.L., Checked by D.S.O.
° 5 year average
°° 3 year average

DISTRICT ONE

RS

APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1921 May No. 13

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

THE PROBLEM OF THE UNMERCHANTABLE TREES IN THE WHITE PINE STANDS.

1. First discussion °

The unmerchantable trees in the white pine stands of north Idaho present a peculiar problem to the silviculturist. The stands contain in addition to the merchantable timber a large number of trees unsaleable because of their general tendency toward defect or because of the lack of demand for the species. A prejudice against some of the species, such as western hemlock and lowland white fir, has grown up on this account; and they have been denominated "inferior." While they do not produce as high quality of wood as the white pine for specialty purposes, a demand for them is growing. And in the future they may serve a very useful purpose in the predicted times of a timber stringency. They scarcely deserve the stigma of "inferior," but have their place in the stand and should be at the control of the silviculturist.

The white pine stands under consideration are usually the B-3 type. (White Pine Marking Rules, Coeur-d'Alene, 1916.) They are mixtures of white pine, western larch, western red cedar, lowland white fir and western hemlock. The usual history of such stands is briefly this: At some time a fire ran over the tract after which white pine and western larch restocked the area. Some hemlock and white pine have come in as scattered individuals. But underneath the stand of white pine and larch an understory of the tolerant species came

° In a later issue of the "Notes" the treatment of unmerchantable trees in stands where the slash is piled and burned will be discussed.

up. The hemlock and white fir when coming in under such conditions of semi-suppression and especially on flat land has a greater tendency to defect than in open stands or on slopes. These stands then contain the merchantable species and various quantities of unmerchantable trees - sometimes very considerable quantities.

In the past, several sales were made in such stands. The white pine and western larch were the only species cut. The land in most cases has been classified as agricultural and the expense of disposing of the unmerchantable trees appeared unjustifiable. Consequently the logging slash was burned broadcast, and the standing unmerchantable trees were killed. In similar stands on lands classified as non-agricultural, the method of cutting employed was to reserve seed blocks and to clean out and broadcast burn the remainder of the area. In the latter cases under consideration the unmerchantable trees were felled previous to the broadcast burning.

On the so-called agricultural land the net result is a condition of windthrowing killed trees which produce a growing fire menace. As a general rule only a small portion of these lands has been cleared for agricultural purposes. The trees killed by the broadcast burn after three years, begin to blow over to pile up criss-cross on the area. The material lies high, dries out quickly and decays slowly. Travel is made almost impossible without expensive trail construction. To fight fires in such tangles of down material is out of the question. Such areas once afire must most generally be given up and the fire fought around the borders. The dangerous fire hazard of areas in this condition is self evident.

The quality of material depends upon the stocking of the original stand. The two following tables set forth tallies taken for the slash disposal study by J. A. Larsen and the writer on two representative areas:

Table No. 1
Trees and Material
Rate per Acre.

Placer Creek
Sec. 6 T.63,N., R. 2 W. Pend Oreille N. F.

Standing Trees				Windfalls		Down Material	
Living		Dead					
Number DBH range	Vol. cu.ft.	Nmbr DBH range	Vol. cu.ft	Number DBH range	Vol. cu. ft	Number pieces	Vol. B.F.
22 4"-18"	584	168 4"-26"	1527	80 4"-8"	1220	None other than windfalls was tallied Windfalls veritable jackstraw was up to 6 feet high.	

Broadcast burned 1916
Conversion factor: Cu. ft. to B. F. 6

Table No. 2
Trees and Material
Rate per Acre.

Schaeffer Sale Area Kaniksu N. F.
c. 20, T. 58 N., R. 4 W.

Standing Trees				Windfalls		Down Material	
Living		Dead					
Number DBH Range	Vol. cu. ft	Number DBH Range	Vol. cu. ft	Number	Vol. Cu. ft	Number pieces	Vol. B.F.
--	--	596 4" & over	1664	36	180	148	15,184

Burned over in summer 1918
Conversion factor cu. ft. to B. F. - 6.

On both the above areas the standing killed trees have not all been windthrown. The hazard is progressively increasing in each case, and when all have come down there will be little to choose between the logging slash and this windthrown slash as to fire hazard. In fact, the choice rather lies with the logging slash, which with needles adhering to the branches and the slash sufficiently compact to maintain burning conditions may be burned in the spring or fall. Whereas the windthrow slash is devoid of needles, the material is loose and will scarcely burn except in the fire season, and then with a conflagration. The treatment of the windthrown slash is not yet worked out. To cut it up, pile and burn it would involve a considerable expense for which funds would be difficult to secure, and to burn it satisfactorily at a safe time to set fire in the forest is, as noted above, very problematical.

In short, the original design of reducing the fire hazard in stands bearing a large amount of unmerchantable trees by broadcast burning the logging slash served the purpose but a short while, and it actually proved to be only a make-shift measure. This method of treatment in similar stands, therefore, may not be considered satisfactory nor should be used.

Two instances of cutting on lands classified as non-agricultural are cited: namely, Jurgens Brothers sale and the Old Fidelity sale on the Kaniksu National Forest. In each case seed blocks were reserved, the remainder of the area clean cut and broadcast burned. The unmerchantable hemlock and white fir were in each case felled previous to the burning. The material was not sufficiently consumed by the first fire to prevent a second burn on each area. This is a possibility to be expected where a heavy stand of unmerchantable trees are felled and where the burning is done in spring or fall. But under broadcast burning it is the only method of treatment of unmerchantable trees to be recommended. The restrictions to which broadcast burning is subject will be treated in a subsequent issue of the "Notes."

CONCLUSION:

Broadcast burning any cut-over areas bearing a stand of unmerchantable trees whether on land listed as agricultural or non-agricultural cannot be considered a satisfactory measure from the protection viewpoint. The felling of such trees previous to burning is necessary.

W. C. L.

UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

FOREST SERVICE
PRIEST RIVER EXPERIMENT STATION
PRIEST RIVER, IDAHO
AUG 16 1921
RECEIVED
Answered ....

1921 June No. 14

These "notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

CHEMICAL WEED ERADICATION in FOREST NURSERIES

Experiments with weeding by means of chemicals at Savenac Nursery have now progressed to a point where the management has decided to use the method on a commercial scale. This decision is based on results previously reported coupled with the results of this season's test of a green fertilizer crop on the treated soil. The germination and early growth of field peas has not been interfered with. Additional records of weed growth during the second season after treatment have been taken. These confirm previous observations that the treatment is practically 100% efficient in preventing the growth of weeds even during the second season.

Injury to the pea crop was especially feared at the time of germination, since the chemical was deadly to all native weeds of the angiosperm group.

From the research standpoint the study is still incomplete. We have yet to observe the effect of treated soil upon the formation of nitrogen fixing nodules on the roots of the peas, to compare the relative development of the fertilizer crop in treated and untreated plots, and to follow pine transplants and seedlings into the field to observe growth and survival. If all goes well we shall be able to clinch our arguments in favor of the method by 1926.

For the benefit of those who may not have seen previous items on this subject, the method and its effects are briefly enumerated here.

1-1/8 oz. of zinc sulphate in a gallon of water applied at the time of sowing to each 4 square feet of seed bed area succeeds in preventing practically all weed growth for two seasons after treatment, tends to stimulate first year germination of western white and western yellow pine, without any discernable injury to the stock, and apparently does not interfere with the use of field peas as a green fertilizer crop as early as one year after the treatment.

Without specific tests, it is unsafe to assume that equally promising results can be secured on other soils or with other species of tree seedlings.

W. G. Wahlenberg.

June 9, 1921.

HELENA, MONTANA
AUG 8 - 1921
Answered

UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

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921 July No. 15

hese Notes are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus nd by Field men, on the Practice of Forestry in Montana and Idaho. ddress communications to the District Forester, Missoula, Montana.

Precipitation in Relation to Forest Fires

In discussing the influence of precipitation on forest ires it is necessary to note the amount which falls during the entire ear and during different months in various sections, as well as the mount which falls at different elevations. Of considerable value is it also to understand seasonal or periodic fluctuations and the aws which govern these. Information in respect to the latter is yet ery meager.

Idaho and the section to the west of the Bitterroot ountains partakes of the Pacific coast climate which shows a heavy recipitation during the colder months and a very light rainfall in ummer. The main reason is that in winter the land is colder than the ocean and in summer the reverse is true, and since the winds are lmost invariably blowing from the ocean its influence over the land is all the more exerted. On the eastern side of the Continental ivide the inland type of precipitation which shows light winter and reater summer downpour prevails. Flathead valley and the interountain sections are intermediate between these two main types of recipitation. This will at once become apparent by drawing curves r each on the same sheet of paper.

Average Rainfall by Months (Inches)

Month	April	May	June	July	Aug.	Sept.	Total Jul.& Aug.
Section							
North Idaho	1.78	2.60	2.07	1.50	0.92	1.94	2.44
Central Idaho	1.95	2.24	1.56	0.70	0.70	1.26	1.40
S. W. Montana	1.05	2.08	2.32	1.15	0.90	1.28	2.05
S. Central Montana	1.30	2.85	2.46	1.37	1.06	1.45	2.43
N. Central Montana	1.09	2.67	3.00	1.72	1.20	1.48	2.92

This shows that the Idaho sections and Southwest Montana receive the least rainfall. These conditions are reflected in the relatively large area per fire in these sections. The causes of the differences are mainly topographic.

It will be of interest to review the amount of rain which fell during some of the worst fire seasons:

Month	April	May	June	July	Aug.	Sept.	July & Aug.
Section							
North Idaho							
1910	0.89	1.73	2.01	1.80	1.17	3.33	2.97
1917	1.70	3.74	1.61	0.35	1.18	2.27	1.53
1919	0.21	1.24	0.89	0.43	0.38	1.30	0.81

1910 had a great deficit in April and May and high winds and warm weather during July and part of August; 1917, a deficit in June, July and August, and 1919, a deficit for every month including April.

Naturally we have a right to expect more rainfall at higher than at lower elevations. Some relations are shown in the following table:

Elev.	Month Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
3115	Billings	0.69	0.42	0.82	1.20	2.85	2.44	1.06	1.08	1.10
5548	Redlodge	0.84	0.86	1.68	2.55	4.32	2.46	1.37	1.00	1.80
6082	Bowen	1.03	0.80	0.75	0.59	1.61	2.07	1.19	0.83	1.21
200	Yellowstone Park	2.19	1.77	2.27	1.22	2.05	1.82	1.22	1.16	0.98
2157	Coeur d'Alene	3.59	2.36	2.35	1.82	1.92	1.50	0.75	0.49	1.37
770	Wallace	4.80	3.63	3.81	2.32	3.03	2.43	1.44	1.25	2.27
082	Burke	6.50	5.1	4.4	2.2	3.2	2.6	1.7	0.7	2.6

These records show considerable increase in precipitation during the colder months but not as much as we should expect in summer. The difference during July and August is especially disappointing.

Snowfall (1909 to 1919 Inclusive)

Inches

Section	Rec. Av.	1910	1914	1917	1918	1919
North Idaho	82.3	102.3	70.1	137.5	80.5	69.3
Cent. Idaho	64.9	55.7	59.9	128.2	84.6	53.7
N. W. Montana	79.4	65.7	52.8	80.7	76.7	49.4
S. W. Montana	64.5	65.9	55.2	97.2	84.2	36.2
N. Cent. Mont.	53.7	45.4	55.9	84.6	51.3	33.8
S. Cent. Mont.	63.0	66.1	52.5	92.9	72.7	56.1
S. E. Montana	40.7	43.2	21.5	51.6	60.2	23.2

Most sections show a greater than average snowfall during 1917 and 1918 and about average 1910. The deficit in 1919 is very pronounced. The fact that 1917 had much snow and still proved a bad fire season indicates that the amount of snow which falls plays little importance in averting a fire season the following summer. Ordinarily the May and June rainfall soaks up the ground anyway after the snow has melted at the lower elevations, but in the mountains most of the usual spring rains fall on the snow layer. If, therefore, the spring rain fails and the snow layer is deficient, an evident deficit is formed. If, moreover, as in the case of 1919, the snow settles on hard frozen ground and melts when the ground is frozen, and when furthermore there is a marked deficit in the spring rainfall, we must indeed face a critical situation.

The question of seasonal fluctuations is a difficult one to settle. Records from 1880 to 1919 for Walla Walla, Missoula, and Spokane for the west slope and for Missoula, Helena and Miles City, for the east slope, have been worked up. These show a fairly regular interval of low annual precipitation every third year and a fifteen-year period of very low annuals, 1889, 1904 and 1919. A low annual is usually but not invariably accompanied by a dry summer The last three years, 1917, 1918 and 1919, appear to have been very unusual in the precipitation deficit. Old timers say that 1889 and 1904 were very smokey and we do not need to ask them about 1910. The records do not extend over sufficiently long period to enable us to conclude anything definite in this regard.

Much moisture falls in the forest from fog in damp weather. This happens when the trees are colder than the air and thereby condenses the moisture in the air. It is spoken of as occult condensation.

In the Pacific Northwest one of the surest signs of rain is increase in wind and drop in air temperature. This usually occurs at the approach of a low pressure area which is a part of the continental pressure system. Unfortunately the Northwest has too many high pressure areas in summer. These cause clear, warm weather and somewhat high winds in the afternoons.

Studies of the relation of precipitation and fires 1909-1919 show that it is necessary to have an average of 2 inches per month to prevent bad fire conditions. If May is deficient ard June dry we have June fires. If June has 2 inches or more forest fires in July are not so serious and a July deficit, as in the case of 1910, when most of the fires raged in the first half of August, appears to be a serious matter. All combinations for the worst seemed to have operated to produce an unusually bad season in 1919.

Priest River Experiment Station. J. A. Larsen.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

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These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

FIELD CONFERENCE OF INVESTIGATORS IN SILVICULTURE.

It was arranged that the writer join Dr. J. J. Hofmann, Director of the Wind River Experiment Station, and Mr. R. H. Weidman, liaison officer in silvical investigations of District 6, in a trip to the Blue Mountains of Oregon. The trip occupied the greater part of the month of June.

The Wind River Experiment Station at Stabler, Washington, in the heart of the Douglas fir region, was visited, however, before beginning the trip to the Blue Mountains. The investigations carried on by Dr. Hofmann were found informative. The well known Yacolt burn, which covered over 100 square miles in 1902, was visited, or a small area of it was traversed. This burn is the scene of Dr. Hofmann's intensive investigations or reproduction after burns. Despite a severe burn in 1902 of a virgin stand consisting of Douglas fir. Noble fir, White fir and other species, an abundant stand of reproduction followed the fire. A perusal of Dr. Hofmann's pamphlet will explain this phase. The study of this and the Cispus burn, which burned also in 1902 and was reburned in June, 1918, has demonstrated that seed are stored in the soil by mice and chipmunks. In the absence of other agencies, reproduction may be expected from this source in this region following a first burn. The application of these facts to silvicultural practice has been worked out by Dr. Hofmann.

The visit to the virgin stand of the coast Douglas fir was full of interest. Scattered western white pine of very large dimensions were found in mixture. One tree measured 54 inches in diameter, breast high, and 225 feet high, and contained about 7800 board feet. White pine appears to make excellent development in this region and plantations of it are being made.

Why this species does not form a larger percentage of the present stand is at present not definitely known.

The same problem of the unmerchantable species in the cutting of Douglas fir stands exists in District 6 as that in cutting our white pine stands in District 1. A considerable volume, running in many cases over 20,000 board feet per acre, which is unmerchantable by reason of defect or by lack of economic demand for the present, is often found. This volume is made up for the most part of western hemlock and of the true firs - white and silver. Since the method of cutting is to clear cut and slash burn, the standing unmerchantable trees are killed by the fire and later windthrow to create a very serious fire menace. To obviate this unfortunate condition, methods are proposed to slash the unmerchantable trees previous to broadcast burning. It has also been proposed to withhold such stands from cutting for 10 to 20 years, when much closer utilization may be expected. Hemce a smaller amount of material would be left on the ground. This same problem is present with us in considering broadcast burning in the white pine type, whether on Forest Service, private, or state lands. In short, the leaving of standing unmerchantable trees to be killed by a broadcast burn and later to be windthrown, does not effectively reduce the fire hazard on an area.

The Douglas fir seed study initiated by Mr. T. T. Munger and carried on by Dr. Hofman is commanding the interest of Foresters generally. Seed were at first collected from the different kinds of parent trees, distributed by site and altitude. Germination tests and nursery tests were made on the seed, then seedlings were outplanted on three representative sites. Fully 40,000 seedlings were outplanted and each tagged and recorded. Examinations of all seedlings are made at intervals. Investigation must of necessity run a long period before final conclusions may be drawn. The results should give reliable information on the influence of the condition of parent trees on the progeny as well as the influence of altitude and site on the development of trees. The plant or tree breeding phase of the study would require quite a long period of time if it be carried out. Progress reports on this study will be followed with interest. Many other points were taken up in the Douglas fir regions, but need not be noticed here.

From the Wind River Experiment Station, Dr. Hofmann, Mr. Weidman and the writer made a trip through the Blue Mountains, where Mr. Weidman, who has been studying western yellow pine for the past ten years, conducted us through old and recent cuttings, over his permanent sample plots and over scenes of his studies. Stops were made at Baker, Sumpter River and Burnt River Valleys, at Batesville, at John Day and in the border stands of the Malheur National Forest, and at Bend, Oregon, and vicinity.

In the Sumpter River and Burah River Valleys, several thousand acres of cut over land were observed. The cuttings took place, for the most part, during the placer mining days 20 to 40 years ago. No slash disposal had been made on this Forest. Accidental fires had burnt over possibly not more than 10 percent. The comparative results were striking. In the unburned areas a young stand of good density of yellow pine had come in on the area. Weidman's studies show that fully 50 percent of this reproduction was advance or on the ground at the time of cutting. This area will doubtless produce even aged stands. On the other hand those portions of the valleys which had burned over presented a devastated appearance. Occasionally trees left in the cutting had survived the fire, but reproduction in their vicinity was not conspicuous.

Mr. Weidman concludes, from an extensive study of reproduction in cut over areas on private and Forest Service lands, that the advance reproduction is the most dependable means of restocking the western yellow pine stands in the Blue Mountains. It is better, therefore, to leave the slash as it lies than to burn over the area broadcast, from the silvical point of view. Slash was noted to have pretty well disappeared after 11 or 12 years, especially where a certain amount of grazing was permitted on the area. Slash disposal, then, appears to be almost exclusively a fire protection measure.

Marked instances of recovery in diameter growth were found on old cuttings in the vicinity of Bates and Austin, Oregon. The trees showing the greatest percentage of recovery, however, had badly formed crowns and had been semi-suppressed in the old stands. The increase in volume growth does not increase in the same ratio over the entire stand, for reserved trees which were putting on good growth in the stand before cutting showed no large percentage of increased growth. Hence a maximum rate of growth may be presumed to exist for the trees under given conditions and no treatment may be expected to cause accellerated growth beyond such maximum.

The final results of Mr. Weidman's studies on the advisability of reserving a considerable percentage of the stand for a second cut are awaited with interest. On his permanent sample plot of 45 acres near Bates, Oregon, the wind fall in 7 years following cutting has been almost three times the gross increment on the standing trees. A particularly bad and general wind storm in 1916 accounted for a good proportion of this loss. Yet the question remains whether a reserve should be held as a shelter wood or retained in the virgin stand. The attention of Foresters who are interested in the management of western yellow pine is directed to Mr. Weidman's bulletin, which is due to appear in the near future.

In the vicinity of Bend, Oregon, on the Deschutes National Forest, wide areas of private timber land are being cut over by two large companies which saw in the aggregate 165 million board feet per annum. This cut may be maintained for possibly 20 years. After that the region will not support from the National Forest lands as much as 50 million per annum. The town of Bend is now building on the basis of the support of the present lumber industry. It cannot be seen how it can maintain its present population on the reduced industry when the private lands are cut over, for agricultural development cannot be expected to expand to a great extent.

The pumice region of the Deschutes National Forest was also examined. Rather unusual conditions obtained here. Studies are to be made of the region to discover how reproduction may be secured, for it is generally lacking.

Numerous other matters were examined on the trip, such as the north slope problem in the Whitman National Forest; the results of tractor skidding, with especial reference to damage done to advanced yellow pine forests; the maintenance of forest communities; grazing and reproduction; and grazing and fire protection, but to comment upon these would lengthen this paper beyond reasonable length. Some sample marking was done upon the Whitman National Forest by the party in company with H. T. Gisbourne.

The conferences in the field where the problems were at our feet or before our eyes were enjoyable and instructive to the writer. This type of get-to-gether of investigative men should advance our knowledge of silviculture materially. The benefits of such field trips are difficult to appraise, but are substantial.

W. C. Lowdermilk.

Should we not discuss results, rather than method

UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

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A UNIT OF AREA AS A UNIT OF RESTOCKING

In making examinations of cut-over areas to determine the extent of restocking the individual count of seedlings proved unsatisfactory and misleading. The count of individual seedlings on the fractional part of an acre represented by the plot or strip gave little indication of the average density of restocking or of its distribution. The seedlings might stand in a dense cluster at one corner of the plot or at one end of the strip, and the remainder of the area might be blank. It is just this that happens on some burned areas where western red cedar, white fir and western hemlock seedlings are found in large numbers in protected moist spots. And again, the count of individual seedlings is a slow operation as well as tedious; it is a refinement of method which can not be fully made use of in the results. The type of count needed to give the desired information, must nshow: to what extent the area in question is restocking.

The extent of restocking is more influenced by the distribution of seedlings than by their number. For the mere number of seedlings per acre may be quite misleading as to the desirable distribution and satisfactory restocking of the cut-over tract. But to divide the acre into a number of convenient fractions and to determine what number is restocking, appears to solve the problem. The following method was worked out on this basis.

The unit of restocking was made a unit of area instead of the seedling. This unit, after some consideration, was fixed as one thousandth of an acre. It is 6.6 feet square. Obviously, other sized units might have been used. There was the pull for the smaller unit to give more prominence to the seedling, and again a pull for a larger unit to give more prominence to the mature trees which would eventually possess the area. But realizing the need of a much larger number of seedlings than can be expected to mature to produce favorable forestal conditions and to take care of inevitable losses, as well as the better tree form development, a unit of area, which would indicate the best stocking, was used, namely one thousandth of an acre. A full stocking, namely one or more seedlings - the number in excess of one is not important except as to species - on each fraction, is taken as the ideal, or a standard by which actual restocking may be measured. To determine what is a satisfactory restocking, it is necessary only to conclude as to how many of the fractions or milacres per acre should be occupied by one or more seedlings.

The word milacre is presented with some hesitancy, since to multiply terms needlessly is a crime not often sufficiently punished. But this word, if it be a new one, has already a number of brothers in structure, and at the same time is descriptive; it conveys a definite meaning when it is said that so many milacres per acre are restocking.

The use of the unit of restocking or milacre for a restocking survey, can be readily imagined. It may be used in the form of a strip survey, or in square plots at definite intervals. Generally, it has been found most convenient to run a strip in chain sections. The crew consists of two men. The tally man acts also as compassman, advances with the chain a chain's distance, stops and tallies. The other member of the crew is provided with a light bar 6.6 feet long. He measures off along the chain or tape the length of the bar. Then grasping it at the center, and advancing over the chain, the milacre is indicated, and any seedlings within the unit area are called off by species only, without reference to their number. If a refinement is desired, a single seedling may be tallied with a dot, under the appropriate species heading and 2-5 seedlings of a species by a small plus sign, and more than 6 seedlings of a species by a double plus sign. The tally sheet must be ruled up in advance, so that a small space on paper will be available for plotting the data found on each milacre. Plots instead of the strip may be used at regular intervals. They must of necessity be square. A one half chain square is a convenient size and contains 25 milacres. The milacre so used permits a recording of the restocking by units of area without the necessity of counting the seedlings.

Other obvious uses may be made of the milacre, but need not be noticed at this time.

It is necessary to adjust the conception of numbers in restocking when expressed in terms of milacres. In considering the seedling as the unit, the number per acre may run up into big figures, far beyond any possibility of survival. But in terms of the milacres restocking, one thousand is the maximum, and not often will it be found that a good stand of seedlings will cover each of the 1,000 milacres. But to say that 750 or 500 milacres are restocking presents a definite idea of the distribution, or the extent of restocking.

The method outlined has permitted much more rapid work than the individual count, and at the same time gives the information in a more usable and instructive form.

W. C. Lowdermilk.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

21 September No. 18

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by Field men, on the Practice of Forestry in Idaho and Montana. Address communications to the District Forester, Missoula, Montana.

A METHOD OF REPORTING ON FOREST PLANTATIONS

ote: Attached is a copy of a method of reporting on the survival plants in forest plantations as prepared by D. S. Olsen, Chief Planting for D-1, which may be of interest.

Referring to Applied Forestry Notes No. 17: "We have found in examinations of old plantations, as you found in your study of restocking on cut-over areas, the desirability of securing the distribution of the reproduction over that of the mere count of reproduction as represented by a sample row or plot. This past season we have used the following method with the special form which is enclosed.

In the case of a staked row, our starting point is the staked row sign-post at tree No. 1 on that row. We go up the row, for example, and find the first five trees alive, that is, living planted trees at each stake. A dot representing each living tree is marked down in appropriate squares on the form under the caption "thrifty". The sixth stake shows the tree to be dead or missing. We are immediately concerned with the possible chance that natural reproduction may be filling in that fail space. Our sixth square in the row under the caption "thrifty" is left blank. If we find a live tree coming in naturally within a radius of fou[illegible]eet (our spacing in the plantation is eight feet) a dot is placed under the caption "larch reproduction", or lodgepole pine reproduction as the case may be, in the sixth space.

In the case of old plantations where it is felt that the surviving tree is permanently established, no record of natural reproduction coming in where living planted trees are found is charted on this form. A general note of that occurrence is made, but it is only, as stated above, where such natural reproduction falls within our fail space that such trees are actually charted. If the sample row representing the area has been examined, it is only necessary then to check up our fail spaces of planted trees and find if natural reproduction has been found at these fail spaces to enable us to draw our conclusions as to whether unsuccessful portions of the planted areas are filling in naturally or not. In other words, our method seems to be similar to the one you have outlined, except that instead of the milacre as the unit, our unit is the space used in planting that area. That, of course, varies from six to eight feet. This tabulation, after the examination is complete, gives us a graphic picture of the reproduction of that area whether planted or natural. We are able to draw a picture of that area a long time after the examination, after the memory of our observations has become stale, merely by glancing at the dots. Our map shows the location of the staked row, our first dot the starting point. The map also shows the number of staked trees in the row. By glancing down the column of dots we find the survival becoming less as we get near the end, indicating the survival less at the end of the staked row. If the staked row ends on the ridge, our conclusions are that survival is less on the ridge. If there is a gap of fifty spaces in a column of thrifty trees half-way down the column, we can scale this off on our contour planting map and find, perhaps, that the sample row crosses a severe exposure, rocky ground, or some high dry knoll. Of course, those points are generally noted in the field at the time the area is being examined, but often times one neglects making the entry on the form or the examination is made by someone unaccustomed to the work, and does not have all of those points in mind or forgets. In that case, the work is not lost as long as we have this graphic representation."

D. S. OLSON,

Chief of Planting.

Sample Form to Indicate the Method of Tallying

Lolo N.F. Plantation. Misc-P-39 Area 320 Spec.& Age Class. I-2 Y.P. Method Mattock

Spacing 8x8 Date Est. Spr. 1916 Orig. No Per Acre, 680 % Estmd. Staked Rows No. Living Plants....

% Living of Total Planted...... Date Examined.......... Chief of Party..............

STRIP	THRIFTY			UNTHRIFTY			DEAD			REPROD						Aspect	Slope	Cover	Soil	Type	Qual	Remarks
										L L P	D F	W W P	W L									

Each square on the paper represents the planting space in the field.

No. 18-A

Range of White Pine and White Bark Pine:

It is of interest to note that the altitude in ranges of white bark pine (Pinus albicaulis) and Western White pine (Pinus monticola) occasionally overlap for 1,000 feet or more, although the first named species is generally recognized as a tree belonging to the sub-alpine type common to the Hudsonian Life Zone, while the white pine is common to less exposed or less severe sites in the Canadian Life Zone. A very striking case of such overlapping was recently noted in a burn about 30 years old on a steep rocky southwesterly slope on Trestle Creek in the Pend Oreille National Forest. The overlapping range occurred approximately between the 4,000 foot and the 5,000 foot contours. 25-year-old and younger seedlings of both species were making thrifty growth in an open stand mixture of Alpine fir, larch and Douglas fir. There was no difficulty in identification in this case, because cone-bearing individuals of the two species were found growing only a few feet apart. Moreover, there are other striking differences in the appearance of seedlings of the two species when they are seen side by side. A very few individuals of white bark pine were noted in the true white pine type on a flat well below the 4,000 foot contour.

H. R. Flint.

Kempff

UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1921 October No. 19

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, in the practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

CAN TIMBER OWNERS AFFORD TO LEAVE THE SMALL TREES?

The cutting and utilization requirements of each operator are based practically entirely on judgment. There is a wide variation in the cutting and utilization policy of different companies, because different operators have a different conception of what sized trees it pays to log.

This problem has not been sufficiently investigated to enable anyone to arrive at definite conclusions. Detailed time studies, however, have been made for the sawing, skidding and loading operations. The sawing study was based on gross output per crew per hour, for different sized trees, ranging from 10 inches to 48 inches in diameter over the bark at a point about 4½ feet from the ground. The skidding operation was based on gross output per hour per team and teamster for different sized logs. The loading study was based on gross output per hour per loading crew for different sized logs.

The sawing and skidding studies include a wide range of conditions such as slope, surface, brush windfall, etc.

In order to illustrate the difference in cost for different sized trees, the following points are assumed.

(1) A yellow pine chance of 10,000 M ft. B. M. located on 5 to 25% slope.

(2) 90% of volume above 14 inches in diameter, average diameter 22 to 24 inches or about 7 logs per M.

(3) 10% of the volume in 10, 12 and 14 inch trees; averaging 12 inches in diameter or about 24 logs per M.

(4) Cost of saw crew $7.00 per day

(5) " " team and teamster 9.50 " "

(6) Average skidding distance 300 feet

(7) Cost of loading crew 20.00 " "
(Loading done with horses)

Based on these conditions, the following tabulations show the difference in the output per day and cost per M for the sawing, skidding and loading operations.

Table

Comparative costs, by operations, of small and large trees.

Activity	D. B. H	Logs per M	Gross output per hr.	Gross output per day	Cost per crew per day	Cost per M	Dif. in c. per M	% of dif.
	inches		B.F.	B.F.				
Sawing	12	24	400	3,200	$ 7.00	ap. 2.20	1.37	165
"	22-24	7	1060	8,480	"	" 0.83		
Skidding°	12	24	400	3,200	9.50	" 3.00	2.00	200.
"	22-24	7	1200	9,600	"	" 1.00		
Loading	12	24	3800	30,400	20.00	0.66	0.33	100.
"	22-24	7	7600	60,800	"	0.33		

° The average skidding distance is 300 feet.

The output for the loading operation is based on time actually employed in loading. Lost time is not included. The output is more than could be expected, because there is always a certain amount of delay, and lost time, but for the purpose illustrating the difference in output, due to size of timber, the figures are correct.

Below is shown the cost of operation for (a) cutting 100% of the timber and (b) cutting 90% of the timber and leaving the small trees.

Cutting 100% of the timber, the cost per M for sawing, skidding and loading would be as follows:

Improvements $15,000 against 10,000 M	$1.50 per M
Sawing 90% @ 0.83	.75 " "
" 10% @ 2.20	.22 " "
Skidding 90% @ 1.00	.90 " "
" 10% @ 3.00	.30 " "
Loading 90% @ 0.33	.30 " "
" 10% @ 0.66	.07 " "
Total	$4.04 " "

Based on cutting 90% on all trees above 14 inches in diameter the cost would be:

Improvements $15,000 against 9,000 M approx.	$1.67	per	M
Sawing	.83	"	"
Skidding	1.00	"	"
Loading	.33	"	"
Total	$3.83	"	"

Summary

Logging 100%	$4.04	"	"
" 90%	3.83	"	"
Difference or Saving	.21	"	"

These figures indicate that 90% of the timber could be logged, for the three branches of the operation given above, for 21 cents per M cheaper than if all timber is logged.

If the operation was carried in a similar manner from stump to f.o.b. cars, the difference would be much greater.

Some lumbermen will argue that they get a much greater percentage of overrun from the smaller logs than from the large logs, and this will help offset the additional cost of handling the small timber.

This is true if average mill run values are to be used in the calculation, but it must be remembered that the lumber from the small trees has a lower selling value because of lesser widths and lower grades, than the lumber from the larger trees.

In any case, it would pay to leave the small trees, because of the excessive cost of operation. In cases, however, when the timber is sufficiently accessible, and sufficiently easy to log to make the small trees fall within the marginal stumpage, these arguments would not apply.

James W. Girard

Logging Engineer.

white

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DISTRICT ONE

APPLIED FORESTRY NOTES

Silvical Investigations
(Not for Publication)

1921 October No. 20

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

SWAMPER SLASH PILING

It is generally conceded by those who are concerned with the forest problems of Idaho and Montana that the disposal of logging slash is the most important single operation for the protection of timber and for the retention of cut-over areas in a restocking condition. Broadcast burning of slash has generally been in practice since the enactment of State Laws requiring some disposal. The experience with this method is disappointing. That is fulfilling its purpose is seriously questioned.

The alternatives are to leave the slash undisposed of or to pile and burn all, or a portion of it. It has in several instances proved dangerous to permit area after area of undisposed of slash to accumulate. Fires gather uncontrollable momentum under such circumstances. Some type of disposal is indicated; one which will not create a large amount of new inflammable material in killed unmerchantable trees as does broadcast burning; but one which will remove enough of the slash to make it possible to fight fire on the cut-over tract effectively during the fire season. The object of slash disposal has been secured if a fire may be fought with a show of success on the area during the dry period.

The most pertinent question is: What will such disposal cost? The Forest Service at the present time is the only agency which is doing slash disposal on a large scale. Costs and methods of practice are being determined which will serve as reliable guides.

But there are two reasons why the Forest Service costs are larger than an operator may be expected to do the work for. First; an operator on private land may not be expected to carry out silvicultural or slash disposal measures to a degree that the Forest Service finds itself obligated to do under the Acts of Congress. Secondly; the Forest Service under the cooperative clause in sale contracts must throw in a crew following the logging operation. Slash is conseqonetly handled at least twice - with a resultant increase in cost. The operator, on the other hand, in some types (Larch, fir and Western Yellow Pine) may combine the swamping with slash piling,- to be known as "swamper piling". The following method in actual use on the lands of a prominent lumber company in Montana indicates the possibility of swamper piling whereby for the most part will be handled only once. The method is described by Mr. Fred R, Mason as follows:

"After the trees are cut, a gang of swampers begins on the cut logs. The foreman indicates to the swampers where he wants his main skidding trails or roads, and the swampers cut these and make such branch roads as are necessary for the teams to reach all logs.

° "After the roads are made, the swampers limb the logs and round up the slash sufficinet for it to burn up clean.

"The swampers' work independently of the teams, which in some cases do not follow them for a period of from a week to a month. When a team begins to skid logs, there is no waiting for swampers.

"The organization of the skidding crew comprises a team and teamster with a chainer and a skidway man. In some cases where the skidding is long, two or more teams work with one chainer and skidway man. In bunching logs for high wheels, which are used largely on flat ground, the bunching crew or unit consists of one teamster and team with one other man who acts as both chainer and send up man.

"The swampers ususally wowrk in strips with sometimes one and sometimes more men to a strip. The strip is usually a skid road with its tributary logs. When the strip is finished, the men are moved to the next strip, the location of the skidway shown the swampers at the start as the radiating point from which to cut their reads.

"This system is by no means confined to this Company's logging, but is, I believe, rather commonly practised. Aside from the advantage of keeping the teams always busy, and thus keeping up to capacity with less teams at work, the swamping is usually so far ahead of the skidding that the swampers furnish a sort of sinking fund of available men. When a man is wanted at some other place a swamper can be taken off without interfering with the orgaization of other work.

° Emphasis is Mine

"I believe that the system can be applied to the larch-fir type or to other types of timber when the trees do not stand too densely for the sawyers to fell them without crisscrossing them. When such is the case, it is probably better for the teams to work with the swampers to assist them in turning over the under logs."

Fred R. Mason.

Costs of slash piling where it may be combined as above described may be reduced to a nominal figure, almost negligible in fact. Under this method, the object is to dispose of as much of the slash as possible. Wherever it is practicable to throw slash away from young growth or away from trees, it is to be done, and only such slash will be burned. Where slash may not be thrown clear, and when burned would kill trees or young growth to create even more inflammable material, it is to be left undisposed of. Under average conditions, it is found that 50 to 75 percent of the slash may be piled and burned by this method.

Swamper piling may be done at a low figure, but great care must be exercised in burning. The method of burning known as "selective burning" which has met with success in Montana will be described in the next issue of The Applied Forestry Notes.

W. C. Lowdermilk

Lyall or Alpine Larch

Further Notes on Its Range

A characteristic stand of Alpine larch, Larix lyallii, was very recently found on the Pend Oreille National Forest, a locality from which this tree has not previously been reported. The tree occurs as pure stands in small patches and scattered in mixture with alpine fir, white bark pine and Engelmann spruce over a considerable area on the high rocky ridge leading north-easterly from Roman Nose Peak in Sections 15, 16 and 22, Township 61 N, Range 2 W. At elevations ranging from about 6400 feet to about 7000 feet, principally on northerly, noetheasterly, and northwesterly exposures. Specimens were noted that were of good form and up to 18 inches D.B.H. and about 40 feet tall, well formed but limby. A nine-inch tree on which a partial ring count was made was estimated to be 250 to 300 years old, annual rings being very regular in thickness but not much more than four times as thick as a sheet of heavy paper. A very sparse crop of nearly ripe cones was noted on the trees on August 27, and small reproduction and saplings were present in abundance. The soil on which the stand grows is a disintegrated and partly decomposed granitic rock, usually shallow and stony.

H.R.F.

UNITED STATES FOREST SERVICE

DISTRICT ONE

APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1921 November No. 21

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by Field men, on the Practice of Forestry In Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

"SELECTIVE BURNING" OF SLASH

In the previous issue of "The Applied Forestry Notes" swamper piling was shown to be a feasible means of preparing a good portion of logging slash for burning. In this issue a method to be known as "selective burning" is presented. It is particularly applicable to the Western Yellow Pine and Larch-Fir types, but may on trial be applicable largely to other types in the Montana - Idaho region. The method has been in operation in a small way locally for a number of years. In the last two years slash piles have been burned under this method on the operations of two of the foremost operating companies in Montana.

The successful prosecution of this type of burning has been dependent upon the direction of men well experienced in the handling of fire in the woods; of men who comprehend what are satisfactory conditions in the forest, particularly, from the protection viewpoint.

The method is simple in application: it comprises the following specifications.

(I) Spring Burning.

(II) At the first opportunity in the spring the burning crew (of two men) goes over the slash area and sets fire with coaloil torches to those isolated swamper's piles that will burn. Obviously, the slash on southerly slopes in first in condition for burning. Only a portion of the slash will be disposed of in the first going-over.

(III)

Within two weeks, or at a favorable time, the burning crew covers the area again, setting afire such remaining slash piles as will burn. In like manner the area may be gone over the third time or even a fourth, until fully 50 to 75 per cent of the slash is disposed of.

(IV)

Only those slash piles which when burned will not kill young growth or standing trees are set fire. All other slash is left unburned. It is possible to burn many piles with safety to surrounding growth by throwing in on the fire the loose edges of the slash pile.

(V)

The fire must not be permitted to run from pile to pile. Where piles are close together only a pile here and there are set afire. When these have burned down other piles may be lighted and so on. A general conflagration on the area must be prevented.

These are the general guides to the accomplishment of slash disposal by "selective burning". Many details will be worked out by the practical man on the ground. Burning in spring has been found the most satisfactory. Generally the growth of the spring grasses helps to prevent the running of fire from pile to pile. In spring the slash dries out from the top downward, and the soil and duff is most generally still moist when the slash is inflamable. In the fall, on the other hand, the dry slash and duff is wet from the top downward by the fall rain. It is possible that when the slash is once lighted, the fire will run; the vegetative cover is dry and makes it difficult to hold the fires to the limits of the piles.

It has further been found that the work of burning slash is best accomplished with the aid of a map plan. The map should be topographic. The areas first to be burned may be pretty closely located by topography; the southerly slopes will become inflamable first, then the west, east and north slopes in succession. By indicating on the map what portions of the area is burned and unburned, the work is kept under easy control. The map plan applies to large areas, more particularly.

The size of the crew may vary, but it is evident that more than two men would not work well together. Too much of the area would be set afire at one time, or there would be a surplus of man power. The crew is very mobile, one man will cover as much as a quarter section a day setting fire here and there at wide intervals, but it may be necessary that he go over the same area four different times, which would produce a charge approximately sixteen cents an acre for burning. This may not be possible in all cases, but it has been done at even less cost in the Western Yellow Pine type.

The cost of the measure will vary, but for the additional expense caused by more careful supervision to secure swamper piling and the cost of selective burning, the costs are estimated not to exceed 15 cents per M.B.F. They are reasonably expected to be much less. Generally the result secured will be a removal of at least 50 - 75 per cent of the slash, a loss of not more than 20 per cent of the young growth, and a condition of the area which will permit of effective fire fighting in the fire season. To secure these results the work of burning particularly, must be done by responsible and reliable woodsmen who recognize the changing conditions throughout the day and who know the pranks of fire and tricks of wind in drawsfand on slopes.

A comparison of the results of "selective burning" and broadcast burning will be made in an early issue of the Applied Forestry Notes.

W. C. Lowdermilk,
Forest Examiner.

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DIAMETER MEASUREMENT BY THE SHADOW

Arough and ready method of measuring the diameter of a tree is as follows: The tree must be sufficiently isolated for the trunk to cast a clear shadow on the ground. The hand placed at breast high on the tree will, by its shadow, indicate the point of measurement. The width of the shadow at this point is the diameter breast high of the tree.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

APPLIED FORESTRY NOTES

Silvical Investigations

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These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and cooperative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

GERMINATION of SEED in the DUFF UNDER WESTERN WHITE PINE STANDS

by

J. A. Larsen, Forest Examiner.

The results of studies in germination from seed of western white pine in the duff were given in a progress report from Priest River Experiment Station in June. This report includes studies in old B-3[°] and in younger B-2 white pine stands on the Kaniksu Forest.

[°] Footnote: The definition of stands is contained in the standard western white pine marking rules, from which the following is quoted:

> "B - Stands which contain less than 50 trees per acre as described above" (trees 6 to 14 inches d.b.h. thrifty and suitable to increase in growth after cutting).
>
> B-2. In which there are practically no small trees, but in which there are thrifty trees, including some white pines, capable of living thru a ~~record~~ second rotation.
>
> B-3. In which there are no white pine trees evidently able to live thru a second rotation."

In the B-3 stand, six different half-acre plots were established after clear cutting. The slash was disposed of in different ways (See table.) Each half-acre plot was sub-divided into 20-foot squares to facilitate counting and mapping. Each seedling was mapped so as to show its relation to original trees before cutting and to surfaces, whether burned or not. The timber was cut in the summer of 1918 and counts taken in 1919 and 1920.

Plot	Slash Disposal	White Pine Seedlings			Total per acre	W.P.Trees before cutting	Seedlings per tree
		Unburned: surface	Light: Burn	Hard Burn			
		Per Acre					
1	Broadcast spring	382	16.6	0	398.6	5	80
1a	Piled & burned fall	288	0	0	288	6	48
2a	Broadcast burn fall	28	0	0	28	1	28
4a	Winter burning 1919-21	5	0	0	5	3	1.6
2	Unpiled, spring burn	302	54	0	355	5	71
3a	Spring broadcast burn	115	17	0	132	2	57
Average		274	17.5	0	241.5	4	57

Most germination took place in 1919, the year after cutting, and most of it occurred on the unburned ground, none on hard burn and only a few on lightly burned surface. The germination is localized by the old trees and by squirrel caches; 1918 was a good seed year for white pine. The paucity of seedlings is doubtless due to the decadent condition of the white pine and their small number per acre.

Much more encouraging are the results from a study in 150-year B-2 stand at Bryant Creek. On August 27, 1918, two five-acre plots were surveyed, the timber tallied and samples of duff obtained for analysis of seed. The average of the stand shows the following trees per acre: W. P. 45, W. L. 20, D. F. 30, W. R. C. 135, W. F. 50 and W. H. 6. The seed recovered from the duff samples showed that there were present in the duff from 124,000 to 261,000 of white pine seed per acre and great quantities of the other species as well. In the greenhouse where these seed were tested, the following winter, the germination showed that there would be 5,436 white pine per acre, in this stand, no white fir, spruce or hemlock, 11,292 of cedar and 4,847 of larch. By reducing these figures by 28 per cent in order to obtain the average for field germination we still have 1,522 seedlings of white pine per acre. As a matter of fact, an actual count taken on this sale area in 1920, three years after logging, but not on the exact place where the seed had been collected, showed that there were 2,240 white pine seedlings per acre, 516 of larch, 6 of cedar and none of Douglas fir or other species.

The conclusions to be drawn from these studies are:

(1) The amount of white pine seed stored in the duff is dependent upon the number of white pine trees in the original stand and their seed productife capacity.

(II) In old decadent stands of white pine, lesser results must be counted on from seed in the duff than from younger and more thrifty stands.

(III) The preservation of the duff layer favors the restocking of the white pine.

(IV) The burning of the duff layer destroys the stored seed and eliminates the possibility of restocking except by reseeding, or by planting.

(For further data on the amount of germination from seed in duff on sale areas, please see report by W. C. Lowdermilk and J. A. Larsen of Reproduction after Logging in Western White Pine Stands.)

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1922 March No. 23

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by field men, on the practice of forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

SLASH DISPOSAL COMBINED WITH LOGGING IN THE STANDS OF CENTRAL MONTANA

NOTE: The following account of an actual operation by Mr. Clack is very suggestive. The application of this method may have wider use than the author imagines. It would seem that the method would be well adapted to the western yellow pine stands of Montana and Idaho. This article is in line with the purpose of these notes, namely to make known instances of the practice of forestry in the Idaho and Montana region. Articles on similar subjects are desired. Comments on this article are welcomed.

--- W.C.L.

———O———

For several years before entering the Forest Service, I operated a small saw-mill on what is now the Lewis & Clark National Forest. While my operations were not on a large scale, being a cut of about 500 M per annum, yet I feel they were large enough for my observations on the slash disposal question to have some value.

At that time the Forest Service insisted that slash be piled and burned by the operator. The timber was nearly all Douglas fir and Engelmann Spruce. Logging was confined to the winter months.

The first winter I tried making three operations of the slash disposal job: First the logs were swamped out: next in the spring after we were through logging the entire crew went over the area and piled the slash: then later when the ranger became insistent, we made another round and burned the piled slash.

Upon checking up the cost of these several operations, I found the slash disposal cost had amounted to $0.53 per MBF scaled.

The second winter I tried the plan of having the slash piled by the swampers as it was lopped. This method was not an unqualified success; for the skidding of logs tore down and scattered a great number of the slash piles. Also there was the same inconvenience to return to the area at a later date usually when the least convenient to burn the slash on the insistence of the ranger.

The third year I burned the slash as it was made and found that I had ended my slash disposal trouble. The method was as follows: The swampers were doubled up, two men were used where I had had one before. These men would take a shovel full of live coals from the last fire and place it where they intended to burn the next pile. Then they threw on a few dead limbs to get the fire started. After that they threw on the green limbs as they lopped them off. I found by using this method that it took less time to dispose of the slash than by piling, since it was not necessary to use any care to make a neat pile. The fire covered an area of 6 to 8 feet in diameter and a man could throw limbs from a radius of 15 or 20 feet, whereas in piling he generally carried the branches to the pile. I found that by burning as we went my slash disposal cost dropped to 25 cents per MBF.

On checking up my logging costs in the spring, I found that the average amount skidded per day for each team was about 1000 BF greater than for either of the previous winters. My skidding costs were reduced from $0.86 to $0.75 per M.B.F. Doubtless most of this reduction was due to the disposal of slash previous to the skidding. The conditions for the three winters were practically uniform; the wages were the same; the stands of timber were uniform. If that were the case, the gain in skidding should be deducted from the cost of slash disposal, which would reduce the cost per M B.F. from $0.25 to $0.14.

I question if this scheme will work in pine or larch timber. but in Douglas fir and spruce in deep snow I had excellent results.

JOHN M. CLACK
Fire Assistant.

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1922 March No. 24

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NOTE ON THE PATHOLOGICAL EFFECTS OF BLAZING TREES

By

James R. Weir

Forest Pathologist, Office of Investigations in Forest Pathology

Bureau of Plant Industry.

Wounds in trees susceptible to infection serve cull-producing fungi in two ways. A fungus already in the heartwood is enabled to penetrate the exposed tissues and produce sporophores in exactly the same manner that sporophores are produced from branch knots and injuries caused by fire and weather; secondly, wounds are a source of infection from without.

The danger of infecting conifers through mechanical wounding, such as blazes, logging scars and various injuries to the sapwood attending general forest improvement work, largely depends upon the quantity of resin secreted from the exposed surface. For the present purposes the conifers of this region are classified as resinous and non-resinous species. This classification is based entirely on whether or not a tree when blazed secretes a protective coat of resin. The usual anatomical classification is disregarded. A wound in the sapwood of a resinous species is almost immediately protected from infection by a heavy exudation of resin, which is not the case in the latter group. With this observation as a basis, a large number of blazes during the past seven years have been examined in Montana and Idaho, to determine their relation to the entrance or exit of cull-producing fungi, as evidenced by the presence of sporophores on the exposed wood, special attention being given to blazes because they are preventable.

The trees are classified as follows:

Resinous	Non-resinous
Western White Pine	Alpine fir
Western Larch	Engelmann spruce
Douglas fir	Lowland White fir
Lodgepole pine	Western hemlock
Western yellow pine	

The total number of trees examined was 177 - on which were found 104 wounds. 73 wounds bore sporophores of which 10 were on the wounds of the resinous group and 63 on those of the non-resinous group.

The sporophores found on the blazes were of the following species: *Trametes pini*, *Fomes pinicola*, *Fomes laricis*, *Hydnum* sp. (unnamed), *Echinodontium tinctorium*, and *Pholiota adiposa*, and are the species which are responsible for most of the cull in the trunks of coniferous trees in the region studied. *Trametes pini* is more or less common to all conifers, as is *Fomes pinicola*, which is frequently a wound fungus. *Fomes laricis* is chiefly associated with larch in the region studied. The last three named species are practically confined to hemlocks and firs.

The foregoing shows quite clearly the role blazes play in the development of sporophores, also that blazes in non-resinous conifers are a more prolific source of sporophore production than in resinous species.

The danger from blazes may be largely eliminated by making light blazes in the bark and bast which will, in most cases, be quite sufficient for the purpose in hand, and are not readily susceptible to infection. This is particularly true in the case of thick bark trees. By careful manipulation of the ax a blaze in any tree may be made in the bark without injury to the wood, and spores which may be carried on the ax will not find a suitable substratum.

SUMMARY

On the basis of resin secretion from blazes, conifers are classified as resinous and non-resinous. An examination of a number of blazes from each class shows that they play an important part in the development of sporophores of cull-producing fungi, and that blazes in non-resinous species are a more prolific source of sporophore production than in resinous species.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1922 April No.25

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

BARK BEETLES AND THE FOREST

By

James C. Evenden, Assistant Entomologist

U. S. Bureau of Entomology.

With the approach of the 1922 field season it is desired to bring the attention of the private timber owners and Forest Officers, to the depredations of the western pine beetle within our yellow pine forests, and to give to them some practical information relative to the habits, control, etc., of this insect. In southern Oregon on an area supporting a stand of 12 billion feet of yellow pine, the western pine beetle (Dendroctonus brevicomis) has killed more than ten percent of this volume, or about one and one half billion feet, during the past ten years. Work is being started at this time to place this area under complete control.

All species of bark-beetle confine their work to the thin layer of cells directly between the bark and wood, which is called the cambium. Some species remain in the cambium during their transformation from the egg to the adult, while others transform within the inner bark. The adult western pine beetle, when attacking, bores through the bark and constructs long winding galleries in the cambium. This work is peculiar to this species which makes its determination very easy. Along this gallery eggs are deposited which soon hatch into small white grubs, or larvae. These legless larvae excavate short larval mines, or tunnels, in the middle portion of the inner bark. When the larva becomes mature a cell is constructed in which the transformation ~~to~~ the adult takes place. At this time the insect is considered as being in the pupal stage. When the transformation is complete, the adult beetles bore an exit hole through the outer bark and soon after emergence attack other trees. The number of these broods, or generations, varies in different sections, depending upon the length of the summer, or active season. In areas where there are two generations per year, the overwintered broods emerge in the spring and attack new trees, the broods from which mature in time to emerge and attack other trees before the winter or inactive season.

Insect infested trees can be located by the discoloration of the foliage. In different localities the discoloration of the needles varies, so that it is always necessary to examine trees to determine the insect development corresponding to the foliage color. Care must be exercised in order to separate the trees containing insect broods and those from which the beetles of the previous generation have emerged.

After a tree has once been attacked, it cannot be saved, but the broods can be destroyed which will prevent the subsequent attack of other trees. If there were no mortality, the insects which would develop from the broods of one tree could, upon emergency, attack and kill several others of the same size. Under favorable conditions an infestation can increase very rapidly. As the grub stage of the western pine beetle is passed within the bark its destruction is necessary in order to kill the insects. This is accomplished by felling the trees and burning the peeled bark, or by placing the logs in water, or severely scorching the entire unpeeled surface of the tree. Mr. J. M. Miller, Assistant Forest Entomologist, Northfork, California, has demonstrated that in southern Oregon and California, if the inner surface of the peeled bark is exposed to the sun the resulting heat will kill the insects. A bark temperature of 115-120 Fahr., results in a 100 percent mortality in less than one hour, and bark lying in the sun will reach this temperature when the thermometer in the shade registers from 80-90 degrees. This method eliminates the fire risk which is present during summer control work. A thorough test of this method will be conducted at this station during the coming season.

Control work should not be sporadic, but should be under a permanent policy which gives the greatest saving of timber with the least expenditure by keeping the infestation at a low point. However, as it is necessary for the beetles to be in great numbers before they can successfully overcome the resistance of a tree, it is only necessary to aid nature to the extent of reducing their numbers so that they can no longer kill healthy mature timber.

There are four Forest Insect Field Stations in the west which are maintained by the Bureau of Entomology. The officers in charge of these stations, which are located at Northfork, California; Ashland, Oregon; Coeur d'Alene, Idaho; and Colorado Springs, Colorado, are always anxious to be of assistance to the timbermen of the west.

Coeur d'Alene, Idaho

March 22, 1922.

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DISTRICT ONE

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APPLIED FORESTRY NOTES

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These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by field men, on the practice of forestry in Montana and Idaho. Address communications to the District Forester, Missoula, Montana.

THE PROBLEM OF SLASH DISPOSAL

The disposal of logging slash in the Forests of the Northern Rockies is the principal problem in the practice of Silviculture on the National Forest lands and is the crux of the protection problem on private forest lands. This problem deserves the attention and application of the foresters and loggers of the region, and discussion of it is desired for issues of the APPLIED FORESTRY NOTES from Forest officers, lumbermen, loggers, and others interested directly in the woods end of forestry in the Inland Empire.

The article in the present issue is very suggestive. How far may it be made applicable to the forests of this region? May not the costs of slash disposal be reduced by the use of this method? - W. C. L.

MORE ABOUT PROGRESSIVE SLASH DISPOSAL

By H. R. Flint

The article by Fire Assistant Clack in No. 25 of APPLIED FORESTRY NOTES undoubtedly points the way to a solution of much of the slash disposal problem which confronts Forest officials in District One, - a problem on which an astonishingly small amount of progress has been made in a dozen years.

More than fifteen years ago this problem in a form just as acute, just as urgent, and on fully as large a scale confronted the timber sale men in charge of operations in Government timber on the Chippewa Indian Reservation in Minnesota. These men without any previous experience in slash disposal or in technical forestry met with the problem in a simple businesslike manner. They informed the operator that the slash disposal was his responsibility, that it must keep pace with the logging operation, and that seed trees and young growth must not be damaged in the logging process. For violation of the first stipulation operations were summarily suspended. For violations of the second, double stumpage rates on damaged seed trees were imposed and operations were promptly suspended if the offense was persisted in.

After a number of brief but sharp and decisive skirmishes the operators, every one of them conservative old time loggers, decided that results would probably be cheaper than evasion and with true loggers' resourcefulness they solved the problem and met the situation in exactly the manner described by Mr. Clack and with results equally as gratifying. The cost of the work was unbelievably low and the damage to the remaining stand entirely negligible.

In one winter on a single Ranger District the slash from 44 million feet of timber, chiefly red pine and white pine, was perfectly disposed of between October 1 and April 1 and the swampers who did the work completed their task on the same date that the skidding teams were taken off. The first snow fell in October and remained on the ground throughout the operation augmented by frequent storms until there was at least two feet on the ground during the latter part of the winter.

Climatic conditions, topography and the character of the slash were very similar indeed to those encountered in winter logging in District One. The stand averaged 11 M. ft. per acre on the area actually cut over, in logs that ran 12 to the thousand and not more than 5 logs per tree. Ten percent of the merchantable stand was marked for seed trees and all trees ten inches or less in DBH were retained. On 14 million feet of this cut for which fairly accurate operating costs were available to me, the total cost of slash disposal amounted to about 1.4 man-hours per M feet of logs. The operator estimated that one-half of the cost of the slash disposal was offset by increased output of the skidding teams due to the absence of slash and debris when they reached the swamped logs.

An average of three swampers for each skidding team was maintained. But two for each team would have been required had the slash not been burned. The need for the third swamper was entirely due to current slash disposal. One swamper for about each four or five skidding teams was kept busy behind the teams cleaning up debris which was pinned down by the logs or buried with snow so that it could not be conveniently handled by the regular swamping crew. New fires were lighted by embers carried from other fires on a shovel and every fire was "branded in" at least once after it had burned to embers. Fires were kept relatively small and spaced at rather close intervals because of the discomfort and inconvenience of working close to large fires and to save carrying or throwing debris too far. In extreme cold weather millions of twigsand needles snapped off when the frozen trees hit the ground. This small debris was collected and thrown on the fires, often by the use of four or six tined stable forks. An excellent job of cleaning up was required. The small fires scarcely burned through the wet, frozen humus beneath the pile and of course there was no spreading of fire from the pile, therefore, the forest floor was left nearly intact after the operation except for some disturbance in the skidding trails.

Both swampers and skidders were at all times kept as close to the saws as was consistent with reasonable safety and the entire operation was kept concentrated on the smallest possible area in order that the straw-boss might prevent loafing and also to keep sawed timber from being heavily snowed under before it was swamped and skidded. In the beginning men complained about working near the fires or in the smoke but after the practice was established, no trouble was experienced. The slash from roads and skidways was burned when cut except in dangerous times early in the fall, then it was piled for burning later. Hang-over fires from slash disposal were unknown.

In my personal experience I have burned the fresh slash by this method from Eastern and Western white pine, red pine, Western yellow pine, lodgepole pine, spruce, balsam, cedar, Eastern larch, and some of the hard woods in snow and in rain with very satisfactory results and I firmly believe that if our slash disposal problem as it now exists is ever solved it will be by this method so far as fall, winter and early spring logging is concerned.

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APPLIED FORESTRY NOTES

Silvical Investigations

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1922 April No. 27.

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SEED PRODUCTION OF LODGEPOLE PINE
(Pinus contorta, Loudon)

The following facts are summarized from a final report by Silviculturist C. G. Bates on studies extending from 1912 to 1920 inclusive on the seed production of lodgepole pine. Two series of sample areas were used in the study. Trees were classified by the standard height and crown classifications: namely, Dominant, Co-dominant and Intermediate, Oppressed and Suppressed. The crowns were subdivided into full crown, medium and poorly developed crowns.

The salient facts which may be of interest to the lodgepole pine region of D-1 are summarized as follows:

1. Mature LPP stands will produce and shed none to 800,000 good seeds per acre as a year's crop.

2. Three years ordinary production of seed remain in old cones. The old cones retain the seed for an average of 3 years.

3. Periodicity of cone production is irregular. The failure of a cone crop appears to be related to freezing temperatures at the time of cone flower production.

4. The germination per cent of currently produced seed was 66. and that of seed in old cones was 60 or a difference of about 6 per cent.

5. Of the current seed production

   (a) 25 per cent of all seed were from full crowned dominant trees.

   (b) 43 per cent from the dominant height class, including 3 crown classes.

   (c) 76 per cent from the dominant and co-dominant trees, including 3 crown classes.

6. Of the old cones

   (a) 36 per cent of all seed were produced on dominant trees.

   (b) 81 per cent on dominant and co-dominant trees.

7. The average yearly production per tree per year is approximately 1000 seeds.

Conclusion:

"Under present methods of cutting in lodgepole, trees left for seeding purposes should be at least co-dominant in height and of medium crown width. While opening up the stand may in a general way increase seed-production of the trees left, it is believed that all narrow-crowned trees are hopeless in this respect, as they are in the matter of increased growth.

"It is still doubtful whether in our present improvement cuttings in lodgepole we wish to encourage reproduction very much. If this is definitely decided in the negative, seed production will be automatically practically eliminated (for a time, at least) by cutting all trees of classes II-b° and better.

"Under a clear-cutting system for lodgepole, reproduction can in practically all cases be assured, at least so far as seed supply is concerned, through the tens or hundreds of thousands of seeds per acre contained in unopened cones. Since in many cases too much reproduction may be secured, it is believed a suitable practice of partial burning of the loppings and scattering of the remainder can be and should be worked out for each locality. Even after some success in securing a desirable number of seedlings, the practice would require judgment, since the number of unopened cones varies widely from year to year and place to place."

W.C. Lowdermilk

° II-b = Co-dominant medium crowned tree.

UNITED STATES FOREST SERVICE

DISTRICT ONE

APPLIED FORESTRY NOTES

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"WINTER SLASH DISPOSAL ON THE KANIKSU NATIONAL FOREST." [°]

Any thing which will throw light on the problem of disposing of logging slash is of interest at the present time. One day while running through some copies of old editions of the Kaniksu Ranger, I came across in the February issue for 1912, an account of an experiment on Winter Brush (slash) Burning. This experiment was conducted by Forest Assistant DeCamp when Millar was Forest Supervisor and Meyer H. Wolff was deputy. The Fidelity Lumber Company had not yet gone into bankruptcy and the theory of white pine seed in the duff had not yet been accepted or used in the methods of cutting as a source for the new stand. Seed plots were being reserved on section "26" of the Kaniksu Forest.

It is interesting to know that the disposal of slash was a difficult problem ten years ago, and the efforts made at that time to solve it should stimulate us to work out a solution which will generally satisfy the demand made on the measure. DeCamp's experiments were designed to test the feasibility of burning slash currently with the logging in the winter as was done in Minnesota and elsewhere in the United States. Extracts will be copied from the report.

> "Winter brush burning on the Kaniksu Forest would be a big step towards better fire protection."

> "In Minnesota the contractors sublet the brush piling and burning for $.25 per M, the burning being coincident with logging. So far as is known, however, winter burning

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[°] The Kaniksu National Forest is located in the Western White Pine Region of North Idaho.

has never been attempted before by the Forest Service under conditions similar to those met with here" (Kaniksu).

The weather conditions on the Kaniksu are said to be different from those in Minnesota. In the latter state there is not the succession of thaws and freezes and rain storms and snow storms that bury the slash and bind it with ice, which occurs in the Kaniksu Region. °

The experiment in winter burning was begun on October 21, 1911 in co-operation with the Fidelity Company. The company set aside approximately $700.00 for the experiment to be confined to an area of 100 acres. The work was to be done under the supervision of the Forest Service.

"The experiment was divided into four parts.

1. Burning by swampers during skidding.
2. Burning of piles left by swampers.
3. Burning immediately after falling and before skidding.
4. Burning of piles in the early spring before there is any danger of fire." Methods 1, 2 and 3 were to be tried out first.

The results of the experiment are summarized below.

1. Burning by swampers during skidding: The work was in charge of the woods foreman, who hired enough extra swampers ($2.25 to $2.50 per day) to do the disposal and keep up with the skidding. The wages of extra swampers were charged to slash disposal.

Unfavorable weather conditions delayed the start. Finally the experiment was begun in a snow storm. A crew of seven extra men were added to the regular crew of six swampers and four skidding teams. The difficulty of keeping the fires burning, says DeCamp, and the necessity of keeping the men hopping around to start fires proved it to be a job that could not be handled by the woods foreman under weather conditions that prevailed during the period of the experiment. This method was given up after an acre of slash had been disposed of at a cost of $55.00- ($2.00 per M B.F.). DeCamp then took direct charge of the work and turned his attention to

2. Burning of Piles left by Swampers. The slash was poorly piled - since it was thrown up incident to skidding. A heavy fall of snow had covered up most of the slash and scattered slash covered up with snow had to be given up. The only possibility of burning, says DeCamp, was to start a fire and throw the slash on it. When slash from one tenth of an acre had been disposed of at the rate of $75.00 per acre ($2.50 per M B.F.), the work was shifted to the burning of freshly made slash immediately behind the swampers. This slash was in better burning condition. The

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° Climate and Forest Types, J. A. Larsen. MS: U.S.F.S., Missoula, Mont cost was reduced partly by the aid of favorable weather conditions to $.60 per M B.F.

Apparently some difficulty was experienced in holding men. They disliked the work in the wet snow. The rapid overturn of men slowed down the accomplishments.

To meet this phase of the problem, a reorganization was made; wages were raised to $2.50-$2.75 per day. Men were carefully selected. If they did unsatisfactory work they were fired. A capable foreman was put in charge; he turned in a daily report; close check on conditions and results was kept.

Of the different methods of burning swampers' piles, says DeCamp, the most successful was as follows: "One man bucked up dry wood and distributed it, with waste and oil (1 gal. coal oil to 2 gals. skid oil) to the crew. The other fire men started fires and piled brush on them. The swampers had piled the brush very carelessly. So long as the weather was clear, a layer of dry sticks could be placed on top of a pile, then some oil-soaked waste, another layer of dry wood, the waste lighted and the scattered brush piled on top."

This appears rather an elaborate method of providing for starting fires. It has generally proved best in more recent experience to carry coals with a shovel from a fire to the location of the new fire. Unless weather conditions are very unfavorable, this latter method will work well.

DeCamp continues, saying that the slash from 5 acres was disposed of in this manner for $.60 per M B.F. A snow storm, followed by a chinook, doubled the cost.

3. Burning immediately after felling and before skidding.

In this third experiment, the slash pilers limbed what the sawyers had not done and piled and burned the slash at a cost of $.63 per M B.F. Where timber had been felled in soft snow and had frozen in it, a good portion of the slash could not be got at. This apparently was the most promising method. Further experimentation is needed to establish definite conclusions.

The fourth method of burning piles in early spring was not covered in the account of these experiments.

While the experiments are not conclusive, it appears in the Kaniksu region of North Idaho that the alternate snows and thaws make the disposal of slash currently in the white pine type a difficult and expensive proposition. To make this statement conclusive, however, the weather conditions should be tested out over several years. And the method should be attempted only in that portion of the winter when more favorable conditions may be counted on.

DeCamp states that one half of the cost of slash disposal was chargeable to unnecessary rehandling of slash. To te this out, two of the best men were set to work with a skidding crew (2 swampers). They took the slash from the swampers and burned it. The four men (2 swampers and 2 slash pilers) swampe and burned the slash. In this manner slash on 43 acres was disposed of at a cost of $13.20 per acre or $.20 per M.B.F. This was done under favorable conditions. A storm followed and the cost jumped to $.80 per M B.F.

DeCamp concludes with "The experiment would seem to show thus far that winter burning is impractical."

Conclusion:

The unfavorable weather conditions of the Kaniksu National Forest restricts the time favorable to current slash disposal. The past experience should show that current disposal m be done in the fall and early spring and the period of disposal lengthened beyond its present limits.

The discussion by Forest officers of this manner of slash disposal in the white pine type in winter is needed to cl the matter up more fully. It is planned to carry out some further experiments in slash disposal in the White Pine Type.

W. C. Lowdermilk.
Forest Examiner.

"The dreary wastes, dismantled sawmills, deserted tow so common throughout the Lake States, Pennsylvania and other se tions of the East are depressing reminders of the day when thes regions were the centers of lumber production for the entire country and sustained prosperous communities."

UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1922 May No. 29

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INVESTIGATIONS IN SLASH DISPOSAL
IN THE
WESTERN YELLOW PINE TYPE.

by

James W. Girard, Logging Engineer
W. C. Lowdermilk, Forest Examiner

Introduction:

The cost to the Government of the measure of slash disposal on timber sales in District One is a large annual item. It amounts to approximately $100,000 each year, varying of course with the volume of timber sold. This cost is expressed as a reduction in the stumpage value of timber to cover to the operator the cost occasioned by the disposal of the logging debris. It is reasonable to examine the present methods of disposal to ascertain the effectiveness of the present practice and to discover, if that be possible, means of reducing the costs of the measure where suitable results may, at the same time, be obtained.

The disposal of logging slash, because of the expense of the measure and the impossibility of measuring the sufficiency of the results, is the problem the most difficult of solution connected with the cutting of timber stands on the National Forest sales. Despite the several years practice, a dependable guide in slash disposal is wanting for some of the types.

The purpose of slash disposal is two fold: namely, the reduction of the fire hazard to the safety point, and the favoring of a complete restocking to the desired species. The reduction of the fire hazard is by far the most important objective. And when the hazard is reduced to the safety point the silvicultural demands on the measure are in most cases satisfied. The objective in the reduction of fire hazard is to dispose of sufficient of the logging slash to make possible the effective fighting of fire on the tract during the fire season.

Purpose and Scope:

The general purpose of the study is to determine:

(1) The most economical and practicable method of disposing of logging slash to meet the demands on the measure.

(2) To what extent the disposal of slash is necessary to render a cut-over tract safe in the terms of fire protection. Safety in this sense is understood to mean the possibility of effective suppression of a forest fire on the tract.

The study is designed to be extended to the several types in the District. But the study was initiated in the Western Yellow pine type as being best suited for the start. This report is written on the basis of investigations made on Canyon Creek of the Kootenai National Forest.

The working plan contemplated five series of plots designated by capital letters. They are as follows:

A. Plots:

On these the slash will be disposed of previous to skidding. The slash is to be burned at the time of swamping. Fires are to be built and slash thrown on by the swampers. This method is designated "swamper disposal".

B. Plots:

On these plots the slash is to be piled by the swampers. An additional swamper is to be added to each skidding crew to assist in piling. Slash is to be thrown into the clearings. The piling will, of necessity, be somewhat rough. Burning will take place subsequent to skidding. Especial care is to be taken in the manner of burning. Only those piles which, when burned, will not kill adjacent young growth are to be set afire --"Selective burning" is the method prescribed. This method is known as "swamper piling and selective burning".

C. Plots:

On these plots the disposal will be done subsequent to skidding. Slash is to be piled and burned in one operation, i. e. fires will be started and the slash thrown on. The method will be known as "Forced burning of slash".

D. Plots:

On these plots the method of disposal is to be identical with that used on the C plots. But only sufficient slash will be disposed of to render the cut-over areas "safe" -- or to leave them in a condition which will make it possible effectively to fight a fire thereon during the fire season. The "safe condition" will of necessity be determined on the basis of the judgment of experienced foresters of the region. This method will be known as "Reduction of the hazard to the safety point by forced burning".

E. Plots:

On these the usual practice of piling and burning in two separate operations will be done as check plots.

At the same time the results on the several plots should establish guide cost figures and indicate satisfactory ways of handling slash disposal crews.

A beginning in the general investigation was made by a study of comparative methods of slash disposal on the Baird and Harper timber sale, Canyon Creek, Kootenai Nation Forest. The work was begun on April 19, 1922, and was continued until May 4.

The timber type within the sale area on the Canyon Creek watershed is distinctly western yellow pine. The Timber Appraisal report shows the following:

Species	Vol. MBF	Percentage
Yellow pine	13,400	73
Western larch	3,050	16.5
Douglas fir	1,980	10.5
	18,430	100

Swamper Disposal:

An attempt was made to conduct a study of "swamper disposal" under the A series of plots. By cooperation with Mr. Baird, Manager of the Baird and Harper Lumber Company, two swampers were secured. Fires were started and slash thrown onto the fires. The work was done on a W.S.W. exposure with a gradient of 30 to 50 percent. The dead pine grass which covered the ground was quickly dried out by the sun and winds. Fire began to run over the ground, and necessitated the abandonment of the work under this heading, after one-half day's work.

While no conclusion may be drawn from the work of such short duration, yet the following notes were made and may serve as guides in further work:

1. The wind carries up the slope and inconveniences workmen unless the work progresses down the slope.
2. Start several fires - 3 to 5 for each man, conveniently placed to throw on slash.
3. Let the fires burn down a bit before throwing on a large quantity of slash. The existence of several small fires will make this possible.
4. On slopes the slash can not be thrown down hill because of the smoke nuisance. Throwing to the side should be planned in the location of fires.
5. Keep fires out of down rotting logs, and out of snags.
6. Vary the size of the fire by the quantity of slash thrown on. By this means fires may be located near green trees and kept down to a safe size.

But further investigation is needed to establish the advantage of this method in cost and suitableness to logging operations. It is evident that the method in application on National Forest lands has its limitations. But the chief advantage of workable results by such a method is the extension of the practice of forestry in this region. If private operators may be shown that slash disposal may be done at a nominal cost and will at the same time reduce the cost of skidding and safeguard their logging improvements, camps and timber from fire, they may be reasonably expected to adopt such methods. This particular method has its limitations, but if practicable could be used for a considerable part of the year in the western yellow pine and western larch-Douglas fir types.

Forced Burning: (Burning and piling in one operation)

This method implies the starting of fires and of throwing slash on. A study was made of this method on a 20 acre measured plot. Record of the man hours was kept and a stump scale was made to establish the cost per M.B.F.

The plot was laid off in the NW¼ of Section 19, 10 x 20 chains. See the attached map sheet. The gradient varied between 20 and 60 percent facing in a W: NW direction. The plot boundary lines were run with the standard Forest Service compass and the distances were paced. Stakes were set at the corners and at 5 chain intervals along the clearly blazed lines.

The stand of timber averaged approximately 11 M.B.F. per acre, and was composed of the following species:

Western larch	16 percent
Douglas fir	20 percent
Western yellow pine	64 percent
	100 "

The crew consisted of five to seven men and was already on the ground disposing of slash when the study was begun. The foreman remained in charge of the crew. The investigators laid off the plot, started the work through the foreman, and worked as members of the crew a portion of the time. The hours so worked were charged as so many man hours at the same rate against the job and included in the total. The men comprising the crew were homesteaders for the most part from the community. They were good workers. The men averaged 8 hours on the job.

The work on this plot was begun April 24 and was completed at 3:00 p.m. April 27.

A clean job was done: four-tined pitch forks were used to throw loose needles on the fires. All slash was disposed of. In several instances some slash might have been left and still have satisfied the primary requirement against the measure. But a complete disposal was made to establish the cost of this particular type of work.

The results are set forth in the following tabulation:

Timber stand:

	M.B.F.	Percent	Logs per M.
Western larch	36	16	11
Douglas fir	44	20	13.5
Western yellow pine	139	64	7.3
	219	100	

Average stand, per acre 10.95

Slash Disposal:

Total man hours	240
Total cost	$111.24

Unit rates:

Man hours per acre	12.
Man hours per MBF	1.09
MBF per 8 hour day	7.3
Cost per acre	$5.56
Cost per MBF	$0.508

Piling and burning in two operations, Plot 1, Series E

Alongside the rectangular 20 acre plot was laid off in the same manner another 20 acre plot on which the slash was piled only. The conditions as to exposure, gradient and stand were as nearly similar as could be reasonably expected. The same crew was employed for this work. The work was begun at 3:00 p.m. on April 27 and completed at 10:00 a m on May 3 - no work was done on April 29 and 30. Weather conditions were somewhat less favorable during this period than during the work on the first plot. A soft wet snow stopped the work one day and a part of another.

A clean job was done. Four-tined pitch forks were used to throw loose needles on the piles. The results are set forth in the following tabulation:

Timber stand:

	MBF	Percent	Logs per M.
Western larch	63	24	10.5
Douglas fir	55	22	14.
Western yellow pine	139	54	6.
	257	100	

Average stand per acre 12.8

Slash Disposal:

Total man hours	213
Total cost	$90.10

Unit Rates:

Man hours per acre	10.65
Man hours per MBF	.83
MBF per 8 hour day	9.6
Cost per acre	$4.50
Cost per MBF	0.35

Estimated cost of burning per M*	.05
Total cost per MBF.	$.40

Conclusions:

1. The method of piling and burning in two separate operations is here shown without material doubt to be the cheaper method of disposal. This should hold true of disposal on slopes with gradients above 20 percent. But it is questioned if such a decided difference would be manifest between the two methods on flats.

2. The difference is attributed to the smoke nuisance on the slopes. The smoke carries up hill, or in gusty winds, blows in all directions. But the general direction is up hill. It required the men to throw slash, not down hill which is the most convenient, but to the side or up hill. This slowed down the work materially.

3. The satisfactory methods of starting fires were the use of pitch splinters or the carrying and placing of glowing coals with a shovel from burning piles.

4. Fires needed to be branded in once, for the slash was fresh and ends would not burn if at the edge of the fire.

5. Where piling was done without burning, it was possible to take advantage of swampers piles occasionally and to throw slash down hill on the pile. These advantages without reasonable doubt speeded up the operation and lowered the cost.

6. Despite the possible higher cost of the forced burning method, certain advantages will favor its use on the flatter tracts. The slash is disposed of once for all; the hazard is not carried through a fire season; if a fire accidentally runs and spreads a considerable crew is on hand to suppress it. These advantages may be appraised as being worth 10 to 20 percent of the costs.

7. Knowing what the average daily cut is on any given operation, a crew sufficient to keep the disposal up to date currently may be determined.

* Based on past experience in burning piled slash.

Recommendations:

It is recommended that:

1. Slash on steep slopes be piled and burned in two separate operations.

2. Slash on flat areas be burned and piled in one operation, except under conditions when fires will run.

3. As soon as cutting begins a crew sufficiently large to keep the disposal of slash up to date be put at work. This method will mean a smaller number of slash pilers in the logging camp than under any other arrangement. It will be more satisfactory and fair to the operator, as well as to the Forest Service.

4. A cost of 50 cents per MBF for slash disposal under present wage scale should be sufficient for the western yellow pine type. If costs exceed this amount sufficient justification of the excess in cost should be made.

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DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for publication)

1922 June No. 30

These "Notes" are devoted to the dissemination of established information by Research men of the Forest Service and co-operative Bureaus and by Field men, on the Practice of Forestry in Montana and Idaho. Address communications to the District Forester, Missoula Montana.

A PLEA FOR THE MOUNTAIN STREAM

by

W. C. Lowdermilk.

It has been a wonderful hike this June morning up along one of North Idaho's inimitable mountain streams. The recently constructed road follows the water's edge, here cutting thru soil bank to the country rock and there crossing to the opposite bank on a picturesque log bridge. Along the way the stream banks are cooled by cloisters of shadowy trees. Not far apart burst out of shaded aisles lateral streamlets whipped into white water by their eagerness to join the river waters. Flowerlets enlivened the pleasures of the eye as the bird songs the pleasures of the ear. It seems that each such experience is more rare than the former one.

But occasionally the road passed over a hot sultry stretch of land studded with stumps and bristling with whitening spikes of slash fire killed trees. A hike under a back pack thru several miles of this type of scenery would not heighten the joy of living. As the psalmist blessed the shadow of a great rock in a weary land so would travellers bless the shadow of a green tree. These desolate stretches of road are the occasion of this plea. For if the stream banks are treated in the future as in the past the loss of the charm of this mountain stream is inevitable.

At this point the man who over prides himself on being "practical" will say that this is all very well but that it won't pay to change the past practice. He little suspects that he risks the charge of being too theoretical, namely of holding to the theory that only one way of doing a task exists.

But what is the value of shade- shelter from the wearying rays of a summer sun? Each square foot of shade on our front porches is purchased at a considerable figure. Shade is considered of sufficient value even about office buildings to spend considerable sums of money in providing for it. The value placed upon the shade about our water brooks by people generally is difficult to appraise, but it is high. A few moments of consideration suggests the large sums spent annually in railway fares, in travelling expenses, in hotel bills, in stage fares, in the mountain road depreciation of automobiles, in fishing tackle, in varied camp equipment - all that the delights by the living waters of a shade bordered mountain stream may be had. On the other hand how much would a man expend in these items to pitch a tent in the glaring sun between charred and whistling snags beside unwholesome waters cluttered up with other windthrown snags?

Nor should this shade along streams cost any considerable sum of money. Provision for it is a very simple matter and inexpensive. It is unnecessary even to sacrifice eleven dollar white pine stumpage for this purpose. It is only necessary to leave the unmerchantable trees, usually comprising western hemlock and white fir, living to a distance of 150 to 200 feet on each side of streams. To do this, however, it is necessary to dispose of the slash from the felled trees with care, so that in burning it, fires neither run over the ground nor kill the remaining trees. It means first, the piling of the slash in clear ground away from down punkey logs and away from standing trees, and second, the burning of these piles in the spring with care. It is a simple measure and feasible. The increased value of the river bank stumpage should bear this slight expense. It is a measure that should be required, if not done voluntarily, as a matter of civic pride and good citizenship.

But aside from these considerations such a measure will justify itself in the reduced hazard from forest fires. How much less is the possibility of the cigarette stub, tossed aside by an unthinking and irresponsible person, to set the country afire in the clean shaded forest floor than in a littered up sun baked road side! It will pay if based on no other grounds. Yet again it will pay in the increased income to the region and in the good will of the community. However that may be, I hope that in years to come others may share with me the same exhilerating hike along the banks of one of North Idaho's inimitable mountain streams - a valuable heritage of the commonwealth.

On the Little North Fork of the Coeur d' Alene.

June 3, 1922.

MARKING AND HIGH STUMPS

Sometimes it is difficult to keep the heights of stumps down to the specifications of timber sale agreements, where saw crews are changing frequently. A method in use by G. C. Earle of the Coeur d' Alene National Forest is working well. The stump cut is required to be made below the trunk blaze, which is placed low enough to assure a proper stump height. If the two marking blazes are left on a stump a fine or penalty is exacted. The method is expeditious and lessens misunderstandings. At the same time it requires an understanding of the possibilities in sawing. It calls for careful marking. The method has therefore a double advantage.

-W. C. Lowdermilk.

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DISPOSAL OF SLASH ON SLOPES

by

W. C. Lowdermilk.

The burning of slash piles in the white pine type on slopes with a gradient of 40 per cent and over is a precarious operation. Too often fire leaves the confines of the slash pile and scurries up slope to set fire to down logs, standing snags or to injure the roots of reserved trees. The influence of the slope on the drying conditions and on the action of fire is responsible for much of the trouble. Slopes are quickly dried out, wind movement is greater on them than on flats, and the sun's action on southerly exposures approaches equatorial insolation. These factors tend to dry out the surface inflammable material in a short time following rains.

In burning, the flames from slash piles lean up hill and dry out the duff surface and other inflammable material on the up hill side. With this action is created a stimulated up hill draft of wind. All factors foster the escape up hill of the fire.

Until, however, some assurance of control of fire, in other words the localization of it, can be counted on, the marking of timber on slopes should reserve less trees. The injuries to the tree roots render the tree liable to bark beetle attacks, fungal attacks and to death or windthrow. Assurance of control is needed.

In going over some areas where fires had run up hill from the burning piles and had killed numerous trees, the most frequent cause appeared to be the faulty location of slash piles. The reader doubtless has many times watched the fires burning slash piles on slopes. In those cases where the pile was placed on windfalls - which most commonly lie up and down the slope the fire may often be seen to dart up on the under side of the windfall as a chipmunk. From one windfall it carries on to another - or to a snag until the wayward fire has soon set punky logs afire and snags which may hide away the smoldering germ of a "hold over fire" in the fire season. This is a serious possibility in addition to the injuries possible to reserved trees. Only expensive patrol will make such an area safe. And up go burning costs.

Despite careful instructions to workmen, it is hard to secure the proper placing of piles, - namely in clearings - as in skidding trails, free of other inflammable material. The rapid overturn of labor militates against the effective training of crews. Some method, therefore, to fix the position of piles and to assure their proper location under all conditions seemed to be a definite need.

To accomplish this purpose stakes were driven to designate the location of the piles. The stakes were cut with an axe from good sized branches near at hand. They were set 2½ to 3 feet high. To demonstrate the practicability of this measure, stakes were set for a considerable portion of a logging unit. The advantages of staking the position of piles are:

(1) The responsibility for the position of the piles is fixed on the foreman or man in charge of the work.

(2) The sizes of the piles are controlled by the number and placing of the stakes.

(3) The correct position of piles is assured.

The setting of the stakes is a part of the supervision and is to be done by the foreman or the man in charge of the work. One man can set stakes for a crew of 20 to 30 slash pilers.

The burning of the staked piles was noticed to give much better results. Fire escaped less often and most generally burned out completely. But here again the satisfactory burning was conditioned on ideal burning conditions. And on slopes no one condition exists for very long.

For example, in the spring the soil and duff layer is thoroughly moist from the melting snow, - a contrary condition to that of the fall. Bur with a day's sunshine and a brisk breeze and with the hear from the uphill leaning flames, the top covering of the duff is very generally dried out sufficiently to carry fire, - not a large volume of it - but enough to set afire snags and down logs and to ignite dry material about reserved trees.

To remedy this condition it was the practice to designate an extra man to assist the torch man. He threw fresh dirt onto the flames when they started up hill. Generally he was forced to work in smoke and if two different fires were escaping up hill, he had his "hands full". It seemed that this method might be improved upon. Accordingly half moon trenches were dug with a grubbing hoe on the up hill sides of slash piles previous to setting them afire. This was done only when conditions favored the running of fire. In a gentle rain the top covering of the duff was sufficiently moistened to prevent the running of fire. Obviously the trenching was then unnecessary. Enough of the trenches accordingly were made to demonstrate that this measure could be done for about 5 cents per M. B. F. where the piles run two to the M. B. F. It was found in the burning that it is well to place the upper bow of the trench 10 to 15 feet up hill from the pile to prevent the dropping of sparks beyond the trench.

It is obvious that with piles properly placed as is contemplated in the staking, these trenches will do the work. If, on the other hand, piles are placed on windfalls, the trenching avails little.

The chief advantages of the trenching are:

(1) Slash piles may be burned safely over a longer period of time, than when not trenched.

(2) Fighting back the running fire in the heat and smoke is eliminated.

(3) It is simple and not excessively expensive. The results justify its use.

An objection to it was raised; namely that fire would run in spite of the trench. This is somewhat specious. For if conditions favor the fires jumping across these trenches they are assuredly unsafe to burn at all. Whereas with trenching, burning may be continued for several days later than burning without trenching.

In general the proper placing of slash piles is essential for satisfactory burning on slopes. And when so placed half moon trenches on the up hill side of fires make burning safer - generally prevents running fire and gives to the foreman control of the situation. And control is essential to a good job.

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RED BELT INJURY

Two rather extensive areas are reported to be affecte
by what is stated to be the Red Belt Injury by the Laboratory
of Forest Pathology. On the Cabinet National Forest a horizon-
tal band or belt of forest 10 to 20 chains wide and several ~~mil~~
Miles long turned brown and red. A similar occurrence is reported ~~fr~~
From the Jefferson National Forest. In each instance the species
most generally affected is the western yellow pine.

The following is a description of this injury. It appears that most of the trees so affected recover. The principal damage to the forest is the loss in increment occasioned by the killing and injury of the needles. Because of the climatic nature of the cause, nothing may be done to prevent or remedy the injury. It is possible, however, that the weakened condition of the trees may invite the attacks of bark beetles and act as the starting point of an infestation. Careful watch for evidences of a beetle attack is needed following the indication of the Red Belt Injury.

Extract from the Guide to Silvicultural Practice

THE RED BELT INJURY#

The Red Belt Injury is a striking phenomenon which occurs sometimes after a particular combination of weather conditions in some parts of District One. It is detected by the turning brown in appearance of broad horizontal bands of the forest on eastern, southeastern, southern and southwestern exposures. The brown color is caused by the dying of the tree needles. Many of the buds also may die, and some trees may be killed.

Generally the upper portion of the tree crown is affected by this injury, and the branches covered by snow in winter show no evidence of it.

Needles of different ages show a uniform difference in susceptibility to killing by this injury. The older needles suffer the most. Where the damage extends to only a portion of the needles the youngest needles are found to be the survivors. Where again the needles are only partially killed the basal portions remain green. These observations agree with those made by Hartley*, who says, "Assuming that the cause of death was transpiration during the sudden warm periods indicated in the weather records quoted, it might follow that the younger needles have a stronger pull on the water supply than the older ones."

"Apparently the red belt injury is caused by excessive transpiration of the needles during the period when the Chinook winds are blowing. Usually these winds are preceded by a cold spell when the temperature drops below zero, and the ground, the roots and the entire tree are frozen. A sharp rise in temperature, accompanied by warm drying winds and sunshine, rapidly thaws the needles, causes excessive loss of water - which, due to the frozen condition of most of the tree cannot be immediately replaced, and eventually the needles or parts of needles most seriously affected turn brown or red and die."**

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* Hartley, C. P. Notes on winter killing of forest trees. Forest Club Annual. Neb. 4:39-50. 1912.

** Hubert, E. E. Report on the Red Belt Injury of Forest Trees occurring in the vicinity of Helena, Montana. MS. Forest Pathology. 1918.

# Guide to Silvicultural Practice. MS District One, Missoula, Montana.

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"Rain does not penetrate dry ground."

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"The volumes of evaporated moisture (vapor) given off by equal surfaces of water, animal and foliage surface are in the ratio of 1:3:60" -

Professor L. Dumas.

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The forest is a fortification in the struggle for and against water.

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The forest -- the mother of waters.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

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AN OUTLINE OF SLASH DISPOSAL PRACTICE IN DISTRICT ONE.

By W. C. Lowdermilk.

A. Object of Slash Disposal.

The disposal of the slash resulting from a logging operation should accomplish two things, - namely, (1) to reduce the fire hazard to a safety point and (2) to favor the restocking naturally of the logged-off tract. The former objective proves to be by far the major one in this region. It proves that most generally if the fire hazard is reduced effectively the silvicultural demands on the measure are met.

The safety point in the reduction of fire hazard is somewhat difficult to determine. It is, however, based upon the following considerations. The unbroken cover of green timber presents the least hazard on forest lands, and cutting, regardless of the method of slash disposal, increases the fire hazard of a tract. Slash disposal will not therefore eliminate the fire hazard and protection of cut-over areas may not be dispensed with.

In fact, protection of cut-over lands must be intensified over that of the green timber to keep the burned over areas equal on the two types of area. To eliminate the hazard or to reduce it to a point equal to that of the green timber is out of the question. The point of safety must be considered, therefore, as the reduction of the fire hazard to a status where a forest fire may be fought during the fire season upon the logged off tract with a reasonable show of success. In other words, it must be possible to fight a fire effectively or to suppress it. When this has been accomplished the job is complete as far as the objective in fire protection is affected.

The degree of the reduction of hazard needed from that of the undisposed of slash will vary with the amount and nature of the logging slash. In some types the amount of work necessary to accomplish the desired result will be less than in others. But the original slash generally, either because of the intensity of a fire burning in it or because of the rapidity of spread of fire over the tract, produces hazards against which little headway is possible in combating fires. It is the removal of this uncontrollable element of fires on cut-over areas that the measure of slash disposal is designed to accomplish primarily.

In most instances such a removal of slash will at the same time render conditions on the tract favorable to satisfactory restocking. In other instances, however, additional expenditure may be justified in securing a greater removal of slash than specified under the demand of the protective portion of the measure.

Administrative considerations tend to require a more thorough disposal of slash than is needful. It is difficult to find men to do this type of work whose judgment may be depended upon. In these cases it proves advantageous to require a complete disposal. If only a partial disposal is specified, the result is an unsatisfactory mediocre job generally. Obviously the most complete disposal must be made where the fire menace is the greatest. It is not a simple matter to secure accomplishment of this specification where a slash disposal crew foreman is given discretion. The general practice has consequently been forced to a pretty thorough and complete disposal of all debris 4 inches and less in diameter. Studies are to be made of the disposal of slash to different degrees in the western yellow pine type this spring and summer.

B. Methods of Slash Disposal

The following are specific rules covering the standard practice of slash disposal for the several types in District One.

I. Western Yellow Pine Stands.

1. Pile and burn slash.

2. Fire must not be permitted to run over the logged-off tract.

3. Pile at all seasons and burn in spring or fall.

4. Slash may be burned as piled (forced burning) at an equivalent cost of the two operations of piling and burning separately.

5. In thin stands lop and scatter slash on exposed surfaces.

II. Lodgepole Pine Stands:

(a) In clean cut areas.

1. Windrow slash and burn.

(b) In selection or partial cuttings.

1. Pile and burn slash.

2. Burn in the spring or fall.

3. Combine burning with piling in spring or fall.

III. Western Larch-Douglas Fir Stands.

1. Pile and burn slash.

2. Burn in the spring only except where little or no duff layer is present.

3. Forced burning may be used in spring or fall.

IV. Western White Pine Type.

1. Pile and burn all slash 4" and less in diameter.

2. A large percentage of the duff layer must be preserved. Fire must not be permitted to run over the logged-off tract.

3. Burn piled slash in the spring only except where no duff layer is present.

4. Piling may be done at any season.

5. Forced burning may be done in the spring or late fall at an equivalent cost to that of piling and burning in two operations.

Costs:

A range in cost of slash disposal for each type of stand is given below. The cost refers to the charge against each MBF of merchantable timber cut. Costs vary with the wage scale, and are influenced by weather. The following figures are therefore only indicative.

1. Western Yellow Pine Type - $.50-$.75 per MBF
2. Lodgepole Pine - $.50-$.75 per MBF
3. Western Larch-Douglas Fir- $.50-1.00 per MBF
4. Western White Pine - $.60-1.25 per MBF

In some sections of the white pine type it has been found that a cost per MBF equal to one-sixth of a swamper's gross wage has proved a sufficient amount to dispose of slash as desired.

Fire Breaks.

Fire breaks in slash areas in District One are not considered worth their expense. They do not stop fire, and the momentum gained by slash between fire breaks is sufficient to carry fire across them. It is more advantageous to reduce the amount of slash generally over the tract so as to prevent the development of uncontrollable conflagrations. If back firing be necessary it can be done from hastily construsted fire fighting fire lines and from skid roads.

No costs on the construction of fire breaks available in this District.

Decomposition of Slash:

The rate at which the hazard of logging slash is reduced in time is not definitely known. Dr. James R. Weir, Forest Pathologist, has collected a large amount of data on this subject but has not completed the report. Observations in the slash disposal studies would indicate that the reduction of the hazard to the sefety point varies somewhat with types.

It is for the:

1. W.Y.P. type: 10-20 years
2. L. P.P. type: 10-15 years
3. W.L.D.F. type: 10-15 years
4. W. W. P. type: 10-15 years.

Dr. James R. Weir, well known to the District, will be glad to receive specimens for examination and report in his Washington Office. And Dr. Weir hopes to make a visit to the District next year.

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UNITED STATES FOREST SERVICE

DISTRICT ONE

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APPLIED FORESTRY NOTES

Silvical Investigations

(Not for Publication)

1922 July No. 33

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AMERICAN SEED IN NORWAY

It will be recalled that in 1919 Mr. Anton Smitt of the Norway Forest Experiment Station made a visit throughout the Pacific Northwest. Mr. Smitt spent some time in District One under the guidance of E. F. White. The Following excerpt from a letter from Mr. Smitt may be of interest to foresters of this region. -- W. C. L.

"As a result of my trip, we established first class seed connections over the entire coast from Oregon to Sitka, and have secured a large quantity of seed. x x x x We have secured seed every year from the United States, British Columbia and Alaska. This year we have planted seed in the nurseries for the fifth time, and the great differences in growth and in overwintering which the plants show according to whether the seed came from Oregon, Washington, British Columbia, or Alaska is exceedingly interesting. It is not too much to say that Mr. Hagem, who is the Director of the West Coast Forest Experiment Station is delighted with his nurseries. It is interesting that the results in a large measure correspond with the expectations that we had prior to my trip in America, only with this difference that we must secure our coast seed somewhat farther north than we had anticipated. Evidently that must be secured from Bella Coola to Sitka. To secure coast seed from as far south as Washington or Oregon would evidently result in the freezing of the seedlings during the fall. On the other hand, we expect much of the high mountain seed from Idaho and Montana. Obviously we can say nothing positive as yet on these matters, but the investigations so far point in the direction indicated".

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On Marking°

"It may be well to emphasize at the start, that no set of marking rules can be made self-operative, or will in themselves insure results. Success depends ultimately upon the individuality, the knowledge, the experience and the faithfulness of the timber sale man himself. He must be able to appraise the situation on every acre as it is marked and vary the rules as the condition of the timber present, the presence or absence of advance growth and the yield capacity of the site dictate"-- Duncan Dunning.

° Dunning, Duncan: Some Results of a Cutting Study MS-U.S.F.S. San Francisco.

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"Knowledge of scientific facts does not grow merely by repetition of observation and experiments. It grows by injecting something new into the search or an element of inquiry into the study of results." -- Exp. Sta. Record.

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The Forests as Military Fortifications

"I am struck by the fact that one has not given enough attention to the military role which the forests more and more play in modern warfare. It was the forests of Villers-Coltorets and of Compiegne which saved us in hiding from the view of the enemy and his aviators the masses of men necessary for our counter-attacks. And who will say how much was the service rendered by the small groves and groups of trees which were transformed into secret machine gun nests. x x x x The forest has become the true modern fortification".

-- A French military officer.

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District 1

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No. 34 November 1922

IN EXPLANATION

Although it has been the custom for "Applied Forestry Notes" to appear without reference to a definite schedule, its readers may have noticed a longer interval between issues than usual. Its last appearance, in fact, was at the end of July. At that time the editor and founder, Forest Examiner Lowdermilk, resigned from the Forest Service to accept a position in China. With this issue the responsibility for the paper is taken over by the Priest River Experiment Station. As in the past, its pages in the future will always be open to the results of all forest investigations, whether they be the slash disposal studies of the timber sale man or the more fundamental investigations of the Research man.

R. H. Weidman

WEATHER RECORDS APPLIED TO THE FIRE PROBLEM

By H. T. Gisborne

Forest Examiner.

In the preparation of annual fire reports it is often valuable to compare the number, average size and cost of the fires during the year with the average of previous years. In a similar manner the average weather for one season may be compared to the average for previous seasons and the fact may be brought out that the fire record has been improved in spite of more dangerous weather than usual. A consideration of the weather conditions within a single season may also show the reasons for certain short periods of exceptionally large and expensive fires. The fire report, by itself, does not ordinarily bring out these elements.

which the Forest Service has had to fight against during the season.

Tabulations of weather conditions can be prepared by practically every Forest in this District whether or not there is a weather station within the Forest itself. In nearly all cases there is a full-fledged or cooperative Weather Bureau station not far from the Forest whose records will show the variations in weather from one period to another. Although these records may not show values equal to those obtainable within the Forest still the fluctuations from period to period will undoubtedly be comparable if the recording station is not on the opposite side of some topographic feature such as a pronounced desert or mountain range which acts as a climatic control or barrier.

Copies of the records from all U. S. Weather Bureau stations can be obtained by request from the office in charge of each state. For this District these offices are at Helena, Montana; Boise, Idaho, and Seattle, Washington. Monthly summaries are obtainable which show the precipitation, the maximum and the minimum temperatures for each day at each field station by states.

In tabulating the data to bring out the facts of interest there are several points to be considered. First, the records for the season under study. Second, the records for the preceding five or ten seasons which will supply an average for comparative purposes. Third, the length of the periods to be shown separately. Ten-day periods are recommended since these coincide with the system used in fire reports, also because these short periods bring out very important fluctuations of the weather which are not shown by monthly averages. Fourth, the class of data to be utulized. Precipitation is absolutely necessary; there are, however, three possibilities of using the temperature. The maximum, the minimum and the mean may all be shown if desired, but the maximum seems to have the greatest importance and significance. It has been found, at the Priest River Experiment Station, that evaporation, from Forest Service evaporimeters, fluctuates in noticeable agreement with maximum temperature. Furthermore, the wind velocity is usually highest during the hottest part of the day. As the maximum temperature indicates the heat in the air at the hottest part of the day, and as fires will spread most rapidly with the highest wind velocity, this seems to be a better criterion of fire danger than the temperature at any other time. Inclusion of the minimum and mean temperatures merely serves to confuse the perspective of the situation. When the 10-day averages have been obtained for a period of seasons prior to and inclusive of 1921 they should be plotted on cross section paper. The 10-day averages for the 1922 season should then be plotted, in different colored ink, on the same sheet and the variations within the season and for the season as a whole will become evident.

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APPLIED FORESTRY NOTES

U. S. Forest Service
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No. 35 December 1922

INTENSIVE MANAGEMENT ON A DEMONSTRATION FOREST

By R. H. Weidman

Director, Priest River Experiment Station.

It is not generally realized, perhaps, that the Priest River Experiment Station is unique compared with the other experiment stations of the Forest Service in that it possesses an experimental forest. This forest, which covers a net area of 4,030 acres, is located in the western white pine type of northern Idaho. It was formerly a part of the Kaniksu National Forest and was set aside, when the experiment station was established, for the specific purpose of having a typical forest area to contain unmolested the long-term experiments and investigations to be conducted in the western white pine forest.

One of the important long-term projects is to be the intensive silvicultural management of this tract on the basis of sustained yield. The purpose is to have a demonstration forest on which can be found, in actual operation, annual cutting in accordance with a forest working plan taking into consideration growing stock, rotation, yield and age classes. The idea is to start this intensive menagement now, so that its results and its lessons will be available for application when the time comes for such management on the private holdings and on the important timber-growing national forests of the region.

The forest is well suited for the purpose of management as a demonstration forest. Although it is 14 miles from the railroad, it is fortunately located directly on a river down which logs have been driven for a number of years. The matter of finding a market for the small annual cut allowed is met by the willingness of local operators to take small winter logging contracts. With respect to topography, timber cover, sites and age classes, the forest is representative of the region. The various species and mixtures of the white pine forest are here found in all their characteristic complexity. In the order of their occurrence there are: western larch, Douglas fir, western white pine, western yellow pine, western red cedar, white fir, western hemlock, alpine fir, lodgepole pine and Engelmann spruce.

Some years ago a 20 per cent timber estimate was made of the entire forest, and as a result there are available satisfactory data on volume, species, types and age classes, as well as an excellent type and topographic map. According to this estimate, the volume of the present growing stock is 33,192,000 board feet, of which about 15,000,000 is merchantable timber over 90 years old. Of the merchantable timber 9,000,000 feet are in well stocked stands and the remainder is more open and understocked stands. A preliminary working plan, for which compilation of much of the material has already been done, will soon be prepared. Data on rates of growth and rotations are still to be gotten. Using the data available, it has been possible tentatively to fix an annual cut and to subdivide the forest into compartments or coupes on the basis of sustained yield. An annual cut of 400,000 board feet is indicated as a safe amount at the start. This is largely based on the 9,000,00 feet of merchantable timber in loggable stands and upon the existing knowledge of age classes and yield. At this rate of cutting there is more than enough merchantable timber to last 20 years. Thereafter the age class now nearly 70 years old, which occupies by far the largest proportion of the total area, will be ready for thinning and final cutting operations. It is estimated that by the time the overmature and the slowly growing mature timber is removed, the growth being made in the thrifty young stands will permit raising the annual cut considerably above the figure now set.

The tentative plan contemplates a cutting program covering the next 20 years. This will be confined almost entirely to the merchantable timber in well stocked stands. Under presen conditions, provision cannot be made for the more open and under stocked stands. Two timber sales are scheduled for this winter. For the next three or four winters, compartments have been decided upon for cutting which may be reached without special road construction. Thereafter the building of a mile of road will open up two annual compartments as well as a unit of 2,300 cedar poles; and following that, the extension of this road another mile will make accessible 6,000,000board feet of merchantable timber and more than 7,000 poles. The compartments in this body of timber will be handled so as to distribute the cut in it over eriod of about 15 years.

The silvicultural treatment will include various methods of cutting, adapted to the different kinds of stands, mixtures and sites, and aimed to secure satisfactory reproduction and a rapid growth of timber of the most valuable species.

The time is not so far off, in the more favorable forest regions of this country, when it will be necessary to know how to grow and harvest forest crops on intensively organized areas. The time has practically arrived in New England and the Southern Appalachian region, and it will not be long in coming in parts of northern Idaho and the Pacific Coast. When that time comes there should be demonstration forests to furnish the knowledge then needed. At present it is necessary to go to Europe to see an organized forest in which the various stages of growth are properly represented, in which the slow processes of silviculture are in operation, and in which a regular yield of lumber is being cut every year without reducing the growing stock. It is to have exactly such an example of an organized forest, right at home, where the results will have a direct application, that the demonstration forest at the Priest River Experiment Station is to be put under management.

A WORD FROM CHINA

It seems like a far cry from the abundance of our timber supply to the absolute denudation of China. The following interesting excerpt is from a letter just received from W. C. Lowdermilk, formerly investigative officer in District I and now teaching forestry at the University of Nanking:

> "As one might suspect the Chinese type of civilization has not made provision for forest perpetuation. The forest cover on the hills has been repeatedly removed and at the present time forests are not permitted to regain their place, because the grass and every other vegetative cover is annually cut -- literally shaved off -- bound into bundles and carried by coolies into the city for fuel, This grass fuel is used for cooking only. Fuel for heating is practically unknown among the Chinese. Thus is home life and comfort curtailed by the absence of sufficient fuel, not to mention the absence of a sufficient supply of wood for the needs of industry and dwellings. The shortage of wood has its baneful effects upon all the people".

9K

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No. 36 January 1923

ANOTHER THOUGHT ON SLASH DISPOSAL IN WESTERN WHITE PINE STANDS

By J. A. Larsen
Forest Examiner

There is no blinking the fact that one and the same method of slash disposal, which would become a stereotyped, standardized measure to be followed blindly by all our men and on all sales, cannot and should not be prescribed. The conditions in the field vary for every acre of ground and are diversified according to age of timber, mixture of species, amount of decay, aspect and elevation. And this is manifestly why there are as many opinions concerning this subject as concerning the stripes on Mars. It is for these reasons that we have tried burning in piles, burning in windrows, burning broadcast, forced burning, burning in spring, in fall and in winter, burning at night or during rain, etc. etc.

Standard methods of burning the slash are difficult to devise, for in addition to complications set up by the factors enumerated above, success or failure in burning depends upon moisture content of the duff, and the general character of the summer season whether unusually dry or abnormally wet.

The western white pine stands are located within a geographic unit in which climate plays many pranks and cuts many capers. In twelve years (1910 to 1922) no two seasons are strictly comparable as to the season for rain or warm weather. We know, however, that rains in most cases come in late April or May and in late September, but how much is not certain until after it has been measured. Another thing stands out clearly in regard to this climate: that is a very sudden coming on of hot weather in spring and an equally abrupt lopping off of dry weather in the fall. Often this is so complete as to preclude much fall burning.

What then can a man do? Here is evidently great need for a Ouija board, or for men who can develop a sixth sense. Who of us, by virtue of long experience in this work and by following the vagaries of our Idaho weather, will consciously or unconsciously sense the exact condition in the field? And following that who will then use his originality, ingenuity and best endeavor to pounce upon the slash and get it burned, thus beating this tricky, fickle and most extraordinary climate to it?

We have unusually diversified field conditions; a most undependable climate; therefore, the greater need for originality and ingenuity in man.

A COMMENT FROM DISTRICT 6 ON OUR SLASH DISPOSAL STUDIES

Good Dope. D-1. Lowdermilk and Girard's study of slash disposal (Service Bulletin of October 9, page 2) has given us just the material we have been wanting. For some time we have had a notion that western yellow pine slash might be disposed of by the "burn as you go method", just as they do in the Lake States, but never having been tried the "practical ones" said it wouldn't work here. Now we thank D-1 for the information that it will work in certain sites. It appears that there is about a 10-cent differential in cost in favor of the piling and burning method. Can D-1 tell us whether there is not a saving in the cost of logging, under the "burn as you go method", and if so, how much it amounts to? Perhaps it would be enough to really make the "burn as you go method" cheaper to the operator, everything considered, and if so, for certain seasons of the year it surely has many advantages over the piling and burning of brush.

T.T.M. in "Six-Twenty-Six", Nov.1922

The weather records obtained at the Priest River Experiment Station have been compiled in accordance with the above described procedure. From this compilation it was found that, of the twelve 10-day periods included between June 1 and October 1, 1922, ten periods were warmer and only two were cooler than the averages of the same periods during the six preceding years. In other words, over 80% of the season had an average maximum temperature higher than normal. Eight out of these twelve periods had less precipitation than the averages for the same periods. In other words, there was a relative drought for 66% of the season. The degree of this drought is emphasized by the fact that two successive periods and a total of four periods had no precipitation whatever during the past season whereas the average season shows only one 10-day period with a total of 0.10 inches rainfall as the driest part of the season. Furthermore, the average season shows only two consecutive periods with less than 0.40 inches precipitation per period, whereas during 1922 there were *eleven consecutive* periods, from May 11 to September 1 inclusive, without 0.40 inches of rain in any one period.

Comparing the various periods within the 1922 season it is found that August 1 to 10 experienced the highest average maximum temperature. This period was undoubtedly the peak of the season at the Priest River Station. It was preceded by two periods havin no rainfall whatever and only 0.03 inches arrived at the very end of this period itself. The number of fires in the surrounding forest also reached a peak in the two periods between July 20 and August 10.

Many other facts of interest can be developed by tabulations of simple weather data as outlined above. Their value, however, lies in a correlation of these facts to the records of fires during the same periods. In some cases the weather data may explain the presence of numerous and large fires, in other cases the weather data may indicate the advisability of investigating other sources of information such as incendiarism, laxity of organization, or some other unexpected but active factor whose results have been previously charged against the weather. Such tabulation may also help to bring out the results of improvements in organization and fire fighting methods by demonstrating a smaller number and size of fires during a year of more dangerous weather than the average.

The years 1910 and 1919 are recognized as having been the most dangerous since the organization of the Forest Service. Mr. Flint has found that, of all the area in District 1 burned over from 1908 to 1921 inclusive, 86.7 per cent was burned during the two years 1910 and 1919, while only 13.3 per cent was burned during the other twelve years. Comparable weather records are not readily available for 1910, but for June, July and August, 1919, for the whole states of Montana and Idaho, the average monthly *mean temperature* was 2.7 degrees above normal while the average monthly *total precipitation* was 0.91 inches less than normal. For the same regions and months during 1922 the average monthly mean temperature was 2.35 degrees above normal, and the precipitation 0.13 inches above. Idaho, alone, experienced a deficiency of rainfall during June and July, 1922. It is evident that, for the District as a whole, the 1922 fire season was nearly as warm as the 1919 season. Precipitation was evidently the factor which, together with better fire protection, prevented a recurrence of a peak of danger similar to that of 1919.

Under these conditions during 1922 the Forests of District 1 have decreased the size and cost of the average fire while the number of fires handled increased about seven per cent. Some Forests undoubtedly established good records in spite of weather conditions more unfavorable than usual. It remains for these Forests to show to what the credit is due.

9K

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No. 37 February 1923

A NEW INSECT ENEMY

Last summer various forest officers encountered patches of rusty-crowned timber, here and there, on the Coeur d' Alene and other forests of north Idaho. The patches were in some cases of considerable extent and appeared to be largely in stands containing white fir. Little seemed to be known regarding the cause or whether the effect would be temporary defoliation or death. In this issue Mr. Evenden, of the Bureau of Entomology, gives an account of this new insect damage. An illustrated article by Mr. Evenden on the same subject appears in the February "Timberman".

R. H. W.

THE SPRUCE BUDWORM IN NORTHERN IDAHO

James C. Evenden, Entomologist in Charge
Northern Rocky Mountain Field Station
Coeur d' Alene, Idaho.

During the summer of 1922 it became known that the spruce budworm(Harmologa fumifera), an insect that has been responsible for the destruction of a large volume of timber in the eastern United States, was fairly well established in northern Idaho. The first report of the insect was received in January 1922, from the Forest Supervisor, Kaniksu National Forest, who stated that the hemlock at Priest Lake was being killed. In June 1922 a representative of this station examined this area and found that not only the hemlock, but Engelmann spruce, cedar, white pine, white fir, and larch were being severely defoliated by a small caterpillar. A large number of these were collected and reared to adult moths, which were identified as the spruce budworm.

As the spruce budworm is an American insect it is not known just how long it has been in the West. However, as the writer has recorded it in the Payette and Weiser National Forests, and reports have been received of its presence in other regions, it is apparently fairly well established in northern Idaho. The earliest record of a spruce budworm epidemic in the United States is that the widespread destruction of spruce in the Casco Bay territory was possibly due to this insect. In the years 1878 to 1885 an epidemic of this insect occurred in the New Brunswick and New England woods which, aided by other agencies, caused the death of a large volume of mature spruce and fir. Another epidemic occurred in these woods in 1910 and lasted until 1921. Experts who have made a careful study of this epidemic state that 25 to 57 per cent of the mature fir and a somewhat less per cent of the spruce has been killed throughout Maine, Quebec, and New Brunswick. During the life of these two epidemics the defoliation was the most severe the first few years.

The attacks of the spruce budworm are readily recognized by the apparent fire-scorched appearance of the new growth at the tips of the branches and twigs. In some areas in Idaho where the attack was very severe, the needles of the new growth were entirely stripped from Douglas fir and white fir. With hemlock and larch the needles are fairly well eaten from the entire limb, while with white pine, white fir, Douglas fir, and Engelmann spruce the damage is confined to the new growth at the tips of limbs and twigs. It may be that the severity of the attack is regulated by the abundance of the host material and the number of insects. During June and July, if these limb tips are examined, it will be seen that the needles have been gnawed through at the base, but little bundles of them will still be held together by a few silken threads. In these loose masses the caterpillars are often found. A large per cent of the pupation takes place within or attached to the outside of these nests.

Dr. Blackman, Professor of Entomology, Syracuse University, writes of the seasonal history of the spruce budworm as follows: "The larvae are usually full grown by the first half of June, and, still in their loose shelter of gnawed off needles, transform to pupa. These in the course of the next week or two, give rise to medium sized, brownish gray moths, which in infested regions are flying in numbers during the last week of June and the first half of July. The moths deposit their eggs in small light green masses on the sides of the needles. These eggs are flat and rather scale like and are so placed that they form small oval masses which are so inconspicuous as to escape casual notice. The eggs are all laid before the last of July and the larvae from them hatch in a week or ten days. These minute larvae feed for a time, but perhaps only sparingly, and pass the winter as small partly grown caterpillars. It is in the spring and early summer that their appetite seems most voracious and when they do the most damage".

The future of this epidemic in Idaho is impossible to foresee. In the Eastern part of our continent during epidemics of this insect large volumes of spruce and fir have been destroyed. Should the Idaho epidemic continue for a number of years there is no doubt but that a serious devastation will occur.

Artificial control of forest tree defoliators, except in parks and small woodlots, is practically impossible because of the expense involved. To control insects of this character it would be necessary to destroy a large per cent of the caterpillars by the application of a stomach poison to their food plants. To apply this poison by spraying forest trees is impracticable. The March, 1922, issue of the National Geographic Magazine describes the successful treatment of a grove of catalpa trees in Ohio which were infested by a defoliating insect, by showering poison dust from an airplane. This method seems the most feasible at this time, and may in time become an economic possibility. However, as the use of air machines for low flying over mountainous regions would be an extremely hazardous occupation, this method is hardly feasible with our present equipment. It is possible that a large per cent of the loss incurred during these epidemics could be prevented by the destruction of bark beetles within the areas.

Though as yet none have been recorded by officers of this station, it is hoped that these insects have natural enemies, or that there will be some natural influence that will check this epidemic. In the past the continuance of epidemics of the larch sawfly, pine butterfly, hemlock looper, and other defoliating insects have been prevented by natural agencies, and it is upon this hope that the cessation of the spruce budworm outbreak in Idaho depends.

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No. 38 March 1923

A MILLION A YEAR FOR SMOKE

WHAT RESEARCH IS DOING ON THE PROBLEM

By H. T. Gisborne
Priest River Experiment Station

Within the National Forests of District 1 the United States Government is spending and losing over a million dollars a year because of forest fires. The Forester has stated that fire protection is 90 per cent of forestry for the present in District 1, and he intimates that the present tremendous annual fire loss can be and must be reduced.

To date the principal means of reducing this loss have consisted of improved methods of detection and suppression for use after fires have started. Plans are made ahead of time and men are placed, and the fire fighting machine prepared for action. But on what basis? Largely, past experience and a rough estimate of existing conditions. Last year between May 25 and June 1, weeks before the usual opening of the fire season, the forests of western Washington were subjected to a sudden change of weather conditions which resulted in a loss of millions of dollars worth of standing timber, logs, and logging equipment. Past experience and rough estimates of existing conditions failed completely in recognizing the emergency until it was out of hand. Evidently there are two distinct fields of possible improvement in the fire game, the first being improved methods for putting out fires after they have started and the second being improved methods of preparedness.

During the past year the Priest River Forest Experiment Station commenced an intensive fire study with the object of determining how to recognize several days in advance the action of the causes which are conducive to forest fires. This knowledge should result in big improvements in the methods of preparing for critical fire danger.

Results are Given

"Some of the most important results obtained during the past year may be briefly listed as follows:

The inflammability of all forest fire fuels varies in proportion to the moisture content of each fuel. If forest duff be taken as an indicator of the average of all forest fuels the moisture content of the duff can be used at any hour of the day or night as an index of the varying degree of fire danger.

Experiments have shown that the duff in the northern Idaho white pine forest rarely, if ever, dries out to a moisture content of less than 3%, based on the oven dry weight. With more than a 12% moisture content, the top layer of duff cannot be ignited with a match and spot fires will rarely occur ahead of a big fire as a result of fire brands dropping upon this material. At over 17% moisture content the top layer of duff is too wet to permit a camp fire to dry it out and cause fire to spread extensively. At over 25% moisture content it is assumed that large forest fires will be unable to spread through the duff.

From these determinations six degrees of inflammability, and consequently fire danger, can be differentiated as follows:

Moisture Content Whole layer duff	Inflammability
3 to 6%	Extreme
7 to 9%	High
10 to 12	Medium
13 to 17	Low
18 to 24	Very low
25 or over	None

With the above relations established there is still the problem of measuring the moisture content of the duff conveniently and accurately so that the degree of danger can be recognized. In conventional research practice the moisture content of a material is determined by a method which is altogether too laborious and expensive for daily use at numerous stations. Consequently an attempt was made to devise a more practical method, but with only partial success. Inquiries were also made among research branches of other industries in the hope of discovering some simple instrument already in use for measuring the moisture content of materials. This search was likewise proving unsuccessful when word was received that the U. S. Forest Products Laboratory, which is cooperating in the present study, had invented an instrument to fulfill our requirements.

Forest Products Laboratory Assists

This new instrument, invented by M. E. Dunlap of the Laboratory staff, is simple in design, is easily handled, and is relatively inexpensive in construction. By employing such an instrument and by translating the measurements into terms of inflammability through use of the above table, it should be possible for any forest station to make accurate determinations of the degree of prevailing fire danger, as well as to anticipate the chance of extremely critical conditions which will surely call for exceptional action in fire prevention and suppression.

In the past it has been the custom of nearly all forest fire protective agencies to watch the records of snow depth during the spring months and precipitation during the summer, and to estimate from these records the resultant fire danger to be expected. After at least ten years of such practice it is still impossible to utilize these records, or even more complete measurements including wind, temperature, humidity, and evaporation, and from them deduce in any exact terms the degree of inflammability to be expected. Moisture content of materials, however, or of duff alone as a representative of all fuels, must show the cumulative effect of all weather conditions such as snow depth, precipitation, evaporation, etc., which have preceded the date of measurement of inflammability. Furthermore, prevailing moisture content can be measured with great accuracy and translated into degrees of fire danger in much greater detail than any possible record of weather conditions. Consequently, by means of a simple measurement of moisture content, it should be possible to reduce to secondary importance the collection of weather data as an aid in determining existing fire danger, and at the same time determine the degree of danger much more accurately than has been possible heretofore. Obviously, the determinations of moisture content also can be made to cover various timber types and exposures having different degrees of fire danger yet receiving the same quantity of rainfall according to the weather records.

Possibilities of Forecasting Danger

All foresters and lumbermen are familiar with those atmospheric disturbances called high or low pressure areas which travel in a general west to east direction across the country bringing usually hot, dry weather when high pressures prevail, and cooler, generally moist weather when the pressure is low. These pressure areas and their attendant conditions, which either favor successful fire fighting or greatly impede it, are mapped twice each day by the U. S. Weather Bureau on the basis of reports from numerous stations in the United States, Canada, Alaska, the Hawaiian Islands, and boats traveling on the Pacific Ocean. From these maps the Weather Bureau is then able to predict with considerable accuracy the weather conditions to be expected in northern Idaho and western Montana at least 24 hours and often 48 hours in advance.

Under the present plan the Priest River Experiment Station will receive the special weather forecasts by wireless telegraph from the San Francisco forecast office of the Weather Bureau twice each day showing the conditions to be expected in northern Idaho as far in advance as accurate predictions can be made. It then becomes necessary to show what effect these predicted weather conditions will have upon the existing degree of fire danger before the information will be of maximum value in fire protection. And this is where the moisture content of duff becomes of greatest use in prediction work. Consequently, the moisture content of the duff, and of other materials, will be measured each day and the exact effects of any predicted change in temperature, humidity, evaporation, or precipitation will be computed as closely as possible in order to predict whether the duff next day will contain more moisture or less, and thus predict the probable degree of fire danger.

Obviously, such a prediction of the effect of any change in the weather entails an exact knowledge of how each separate weather element affects the moisture content of the duff. If the maximum temperature is expected to rise 4 degrees higher tomorrow than it was today, what change in the duff moisture content will result? If humidity will be 10 per cent lower tomorrow than today, how much drier will the duff be? If it is going to rain two-tenths of an inch tomorrow will that be sufficient to raise the duff moisture content to a point which precludes fire danger? And if fire danger is eliminated by the expected rainfall, how long will the period of safety last? These and numerous other questions must be answered in order to predict with any accuracy what the degree of fire danger will be.

Systematic Measurements Necessary

During the past year systematic measurements were commenced at the Priest River Experiment Station to provide answers to the above questions. Preliminary tables and curves were obtained to show: the duff moisture content resulting from various amounts of rain; the capacity of the duff for holding moisture; the rate at which duff can absorb water; the amount of run-off or water lost to the duff according to the amount of precipitation; the quantity and duration of rainfall which is just sufficient to cause a minimum of fire danger; and the effect of various rates of evaporation on the duff moisture content. At the Forest Products Laboratory measurements were also made under controlled conditions to determine the moisture content in various classes of duff, down logs and other material according to all possible combinations of temperature and humidity commonly experienced during a fire season.

All of these determinations require exceedingly numerous measurements before dependable data can be obtained, but it is evident from the results to date that we can expect to make very material advances, within the immediate future, in our methods of accurately predicting fire danger. In the meantime accurate determinations of fire danger can be made each day according to the method and instrument previously described, and it is believed that on the basis of these daily determinations the possibility of extreme danger can be foreseen at least a few days in advance of its occurrence. This possibility will be carefully tested at four stations in this District during the coming fire season.

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No. 39 April 1923

PREFATORY NOTE

Although white pine blister rust has not yet appeared in this region, it already exists at Revelstoke, B.C., only 100 miles north of the Idaho boundary. And as Mr. Stillinger points out in this article, it will only be a matter of time until we may have to combat it in our own territory. It is urged, therefore, that lumbermen, forest officers and woodsmen generally take to heart the suggestions for cooperation made in the last paragraph of the article.

It may be mentioned here that the Office of Blister Rust Control is to establish an experimental eradication project at the Priest River Forest Experiment Station this spring. All the currant and gooseberry plants on a permanent sample plot of several hundred acres will be eradicated with the object of determining the costs and efficacy of this method of control in northern Idaho.

R.H.W.

WHITE PINE BLISTER RUST IN THE WEST

C. R. Stillinger, Pathologist,
Office of Blister Rust Control, U. S. Department of Agriculture.

Now that white pine blister rust is known to be firmly established in the West, it behooves every forester and lumberman to become more familiar with this destructive disease. Scouting thus far has shown the disease to be generally present along the Pacific Coast in Washington and British Columbia. Further, it has been found in quite an extensive area around Beaton and Revelstoke, British Columbia, at a point only 100 miles north of the Idaho boundary and at the very edge of the valuable western white pine type.

The pines in Idaho and Montana that are susceptible to the disease are the western white pine or Idaho white pine (Pinus monticola), the white bark pine (Pinus albicaulis) and the limber pine (Pinus flexilis). Associated with these pines there are at least thirteen species of wild currants and gooseberries, which grow under a great variety of site conditions. Consequently, it is very difficult to find a single ecological condition in this region in which one or more of these species is not present.

This disease is different from most plant pests in that it spends part of its life on the white pine tree and part on the leaves of currant and gooseberry plants. All known species of currants and gooseberries and all white pines (pines with five needles in a cluster) are subject to the disease.

White pine blister rust attacks the tree through its needles. From the needle the parasite goes to the young branch and eventually may reach the trunk of the tree. At first there is a slight swelling and yellowish discoloration of the bark, then the bark breaks, and whitish sacs appear in the cracks. These sacs are filled with a powdery substance which is blown to currant and gooseberry leaves. Here it grows and produces little yellowish clusters filled with another powdery substance. This powder is in turn blown from leaf to leaf on the currant and gooseberry plants. In this way the parasite spreads on currants and gooseberries during the summer. Toward the fall little brownish hair-like clusters appear on the under sides of the currant and gooseberry leaves. This is the stage that goes again to the pine. Thus the disease goes from the white pine to the leaf of the currant and gooseberry and finally back to the pine. It can spread from the currant and gooseberry to other currants and gooseberries but cannot spread from pine to pine.

This is the most destructive disease of the white pine that is known. Two types of damage occur: one in which the tree is so severly attacked that all of the branches are killed, and one in which the trunk of the tree is attacked and eventually girdled and killed. The former is the most prevalent method of attack and the most rapid method of killing. Plot studies made at Daisy Lake, British Columbia, where the disease has been present for about ten years in a stand of white pine varying in height from 5 to 50 feet, revealed the fact that 40 per cent of the trees are dead. It is estimated that 96 per cent of the trees on this area will be dead in five years.

Some idea of the damage that has been done by the disease in the eastern white pine areas may be gleaned from the following table. This study was made in 1919 and 1920 by running compass lines across country, examining all pines on a strip one rod wide. At points where infection was greatest on or adjacent to the compass lines, small square plots were laid off and the data recorded separately.

TABLE I

Strip	Miles	Acres	No. pines examined	Infected with blister rust	No. plots	Acres	No. pines examined	Infected with blister rust
Littleton to Piermont, N.H.	39.5	79	6,161	12.5%	213	49.1	7,014	51.5%
Wells River to Barnet, Vt.	28	56	4,002	3.1%	7	1.8	385	6.2%
Lewis to Ausable F'ks., N.Y.	22.9	55.8	10,501	4.9%	13	14.4	12,986	15.8%
Douglas, N.Y.	5.5	11	1,796	6.8%	3	.75	1,469	32.8%
Ipswich, Mass.	4.4	8.8	871	5.7%	9	3.0	637	27.0%
Brunswick to Farmingdale to Woolwich, Me.	38.5	77	7,046	6.3%	11	2.75	970	14.4%
Totals	138.8	287.6	30,377	7.0%	256	71.80	23,461	27.7%

In combating the disease three methods of attack are employed. First, quarantining infected areas, by which all means possible are used to stop the distribution of plants that may carry the disease out of the infected areas. At present quarantine regulations forbid the movement of any currants, gooseberries, or white pine as follows: their importation into the United States from any foreign country; their shipment into the western states from any states in the United States east of and including Minnesota, Iowa, Missouri, Arkansas and Louisiana; their shipment out of the State of Washington to any other state in the United States.

The second method of attack aims at retarding the natural spread of the disease into new communities. The chief means used to accomplish this purpose at present is the destruction of the English black currant in the States of Washington, Oregon, Idaho, and western Montana. Technical investigations and field observations show this species to be about 16 times as liable to infection as any of the cultivated red currants or gooseberries and about 4 times as liable as any wild species of these plants that have been tested. Further, observations in regions where the disease is established indicate that this species is almost invariably the first to show the infection and is the worst agent in establishing and spreading it. For these reasons the destruction of the English black currant, a plant of small economic importance and not extensively planted, will materially retard the disease in its natural spread.

When once the disease has become well established in a community, then local control measures must be used. This consists [illegible] the destruction of all currants and gooseberries within the area to be protected as well as for 300 yards beyond the edge of the area. English black currants are removed for 1200 yards beyond the area. This method of control is based on the fact that the disease cannot spread from pine to pine but must go from pine to a currant or gooseberry leaf and then back to a pine. This means has been in use for some time in the heavily infected pine regions in the eastern states and has given complete control. In the West this method has not as yet been put into use, since the disease has not been found in any of our commercial stands. However, since it may be found at any time in our western commercial stands, experiments are being carried on to determine the best economical methods to be used for this type of work in the West.

Eradication of Ribes (currants and gooseberries) was carried on at Kittery Point, Maine, in 1917 over an area of approximately six square miles, and an average of fifteen Ribes per acre was found. Ten acres of this area containing native pine and cultivated and wild currant bushes and severe infection, were studied in the winter of 1917 and 1918. The following summary shows the effectiveness of this eradication work, the figures being obtained from the ten-acre tract and representing a recheck of approximately 10% of the area:

Total number pines examined 1917, rechecked 1921	612
Total number pines infected with blister rust 1917, rechecked 1921	363
Percentage of pines infected 1917	59%
Number pines dead from blister rust, 1921	204
Per cent pines dead from blister rust, 1921	33-1/3%
Number pines recovered from blister rust, 1921 (branch died before canker reached trunk)	30
Per cent pines recovered from blister rust, 1921	4.8%
Number young pines first examined 1921 (grew since 1917)	146
Number young pines not infected	146
Total number pines not infected since 1917	554

(including 408 live pines examined 1917 and rechecked 1921 plus 146 young pines examined for first time 1921. No pines infected since 1917, or in other words, since Ribes were eradicated).

TABLE XI

SUMMARY OF BLISTER RUST ERADICATION DATA FOR NORTHEASTERN STAT
INCLUDING NEW ENGLAND AND NEW YORK, 1917 TO 1922.

Year	Area Covered in Eradication in acres	No. of Wild Ribes removed	Total cost of removing Wild Ribes °°	Cost per Acre °°°	No. Cultivate Ribes destroy
1917	262,562	°861,353	$ 65,481.24	$0.373	69,514
1918	137,458	2,413,887	°99,388.20	°0.727	22,150
1919	252,043	4,599,948	137,117.05	0.544	27,877
1920	270,657	4,243,983	84,843.80	0.313	25,936
1921	376,745	3,191,967	68,093.70	0.180	15,755
1922	468,042	4,774,333	90,365.12	0.194	17,006
Totals-	1,767,507	20,085,471	545,289.11	0.326	178,238

°Excluding Conn. where data is unavailable.
°°Excluding Mass. where data is unavailable.
°°°Excluding Mass. acreage for 1917 and Conn. acreage for 1918, the cost for covering which is unavailable.

It is now apparent that it is only a matter of time until foresters and lumbermen will have to combat this disease in the forests of Idaho and Montana. Therefore everyone should familiarize himself as thoroughly as possible with this disease, so that he may be constantly on the lookout for it. Further, he should become familiar with the wild Ribes of his territory and note down on a map their location and abundance whenever he encounters them, so that when the disease does appear he will have that information available for judging the situation and determining what action should be take Foresters should also watch for plantings of black currants on isolated farms and in old mining towns located in the forest. When any are found an effort should be made to have the plants destroyed. All plantings of cultivated black currants should be reported. Any suspicious cases should be called to the attention of the Office of Blister Rust Control, 429 Lyon Building, Seattle, Washington, so that the case may be immediately investigated.

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No. 40 May 1923

NOTE

The subject matter of this article by Mr. Olson recently appeared under slightly different treatment as a Forest Service circular in District 1. In order that the excellent and concise information it contains on forest planting for this region may reach the other readers on the wider distribution list of Applied Forestry Notes, it is made the subject of the present issue.

R. H. W.

FOREST PLANTING IN MONTANA AND NORTHERN IDAHO

D. S. Olson, Chief of Planting
District 1, U. S. Forest Service

For several years the federal Forest Service has been reforesting denuded timberland in the United States at the rate of about 10,000 acres a year. Of this area about 3,000 to 4,000 acres is planted each year in Montana and northern Idaho. To date a total of 34,377 acres has been planted in this region, 27,000 acres having been planted in the western white pine type alone. In the region as a whole 80 per cent of the planted area now has an established stand of 100 or more trees per acre, and in the white pine type 90 per cent has an established stand of this amount.

All planting in the region is at present being confined to the western white pine type. The reason for this is that this type contains the most favorable conditions for tree growth, as well as the largest burned areas in need of reforestation. Furthermore, western white pine, which does best and is chiefly used in planting here, is the species of greatest commercial value in the region. The acreage in need of reforestation in the white pine type is not known, but 75,000 acres would be a conservative figure and that would include only areas which had been burned over two or more times. It is the present policy to plant only double burns because in most cases natural reproduction comes in on single burns in the white pine type.

Very little planting has been done since 1915 in the eastern and central portions of Montana. Plantations set out prior to that time as a whole were not successful. The underlying cause for the poor results obtained has been attributed to the inability of the trees, during the first few years, to extend their roots below the point to which the soil dries out at the peak of the summer drought. Unquestionably planting will again be taken up in those parts but not until the science of planting has developed to a point where those exacting requirements to tree establishment can be met.

In the last six years planting in this region has been confined to five national forests: the St. Joe, Coeur d'Alene and Pend Oreille Forests in northern Idaho and the Lolo and Cabinet Forests in western Montana. The planting on the Pend Oreille was completed last year and that on the Lolo will shortly be finished. The Coeur d'Alene Forest has at present the largest acreage surveyed and mapped preparatory to planting. Except for a few experiments, no planting has been done on the large burns of the Clearwater Forest because of their inaccessibility. The largest single plantation in this region covers 4,192 acres and is located on the Little North Fork of the St. Joe River in Idaho.

Direct seeding was abandoned a number of years ago. This means of restocking denuded areas proved a failure chiefly because of rodents and summer droughts. Perhaps if seed had been sown in the quantities that nature so lavishly showers down on the ground, her results could have been duplicated, but the cost of such prolific seeding would be far greater than the cost of raising and planting nursery stock.

A great number of exotics and trees non-indigenous to this region have been tried. The eastern white pine and Japanese larch have showed up well thus far, but whether those trees will hold true to form in later years in this region is of course unknown. No hardwood plantations have been successful. What species have survived the drought have made no growth because of setbacks from frost injury and too short a growing season to mature the winter buds.

To supply the planting stock necessary to reforest 3,000 to 4,000 acres each year, Savenac Forest Nursery, located at Haugan, Montana, and comprising 30 acres under cultivation, turns out 3,000,000 seedlings and transplants a year. To maintain this annual output, the nursery contains about ten million plants in its seed beds and transplant beds. Of this stock, 65 per cent is western white pine, 20 per cent western yellow pine, 15 per cent Engelmann spruce and a small proportion is Douglas fir, western larch and western red cedar. All the seed used for propagating this stock is collected by the Forest Service. Seed plants on the Kaniksu and Bitterroot Forests and at the Nursery handle all the seed extraction.

When finally planted on the burns and denuded areas the trees average 3 years of age, are about 10 inches tall from root to top and set out 8 feet apart. The average cost of planting is about $10 per acre. This covers everything including the cost of seed, raising the stock in the nursery, surveying the area and planting.

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SOME RESULTS OF WINTER SLASH DISPOSAL

By Gerhard Kempff, Forest Ranger
Priest River Experiment Station

Two years ago the writer tried out this method of slash disposal on a small scale in the western white pine type of the Kaniksu National Forest. The method consisted in starting fires and throwing slash on them as the logging progressed. The trial was conducted during January, February and early March under unusually severe weather conditions. Repeated snow storms forced the handling of slash covered with snow from four to twelve inches deep. Unsystematic procedure in the logging made it impossible in one case to start disposal on all the skidways tributary to one rollway until the entire rollway had been abandoned, thus causing unusual difficulties in the handling of snow-laden slash.

The trial of the method covered an area of three and one-half acres lying on a 50 per cent westerly slope. The overwood consisted mainly of white pine, larch and cedar, and furnished an average cut of 16,360 board feet per acre. The understory was a dense stand of advance reproduction, averaging 8 feet high, 40 per cent of which was hemlock. Although the actual cut from the area was rather light, there was the normal amount of slash, due to swamping out long skidways in the heavy underbrush. Three men were employed in the work.

Careful observation and records were made during the progress of the work with the object of determining, from the viewpoint of the man on the job, whether winter slash disposal in this type and locality could be justified from the fire protective, silvicultural and financial standpoints.

As a fire protective measure, winter disposal of slash, of course, was shown by this trial to be an absolutely safe oper[illegible]ion. Of the 51 piles burned there was not one fire that burned beyond the limits of the pile or hung over in rotten wood for more than two days. The fire chances incident to the slash-covered area were eliminated soon after the termination of logging operations. In this connection, however, it must be stated that the area could not be cleaned of the finer material as thoroughly as during fall or spring disposal. The degree to which an area may be cleaned during the winter depends largely upon the systematic procedure of the logging operation so that the disposal can follow always closely on the heels of swamping. Whatever small amounts of slash may remain undisposed, however, due to extremely inclement weather, may be cleaned up cheaply in the spring, which was done in this case.

Silviculturally, this experience showed the advantages to be entirely in favor of progressive burning during the winter. The per cent of the ground cover burned was only a fraction of that destroyed by the pile and burn method in vogue on timber sales at the present time. Larsen and Lowdermilk found in their slash disposal studies that on four representative timber sale areas in mature stands with an average cut of 36.9 M.B.F. per acre, the slash piles covered an average of 24.9 per cent of the area when the method of piling and burning in two separate operations was employed. In the trial of winter disposal here discussed, the burning slash piles covered and destroyed only 0.9 per cent of the ground cover on the area. Although the average cut here was only 16.4 M.B.F. per acre, there was as much slash as in heavier stands because of the large crowns and dense understory. This feature of small amount of surface burned is a great advantage where the conservation of stored seed is an important factor.

It was found that damage to reproduction and reserved trees was held to a minimum. Detailed records taken in connection with 42 piles showed that the average distance at which a tree was killed on the uphill side was 3.2 feet from the edge of the fire. This distance varied for the different species and the month in which burning took place; it was greatest for white pine and increased for all species with the beginning of March. The results on the leeward side of fires on level ground were the same as on the uphill side on slopes. The damage to either side of the fire and downhill was relatively less; least for the downhill side, no killing or serious damage having occurred for a distance greater than 1.5 feet from the edge of the fire. Although records of fire damage of this sort for the pile and burn method are not available for comparison, it is readily apparent that the damage is much greater by that method for the reason that there are more piles and the burning must be done when conditions are dry enough for the piles to burn by themselves.

From a financial standpoint this trial of winter slash disposal did not make a very successful showing. Here, briefly. are the main features. A total of 51 piles were required to clean up the area of 3 1/2 acres. The number of piles handled per man-day was 1.67 or 0.9 pile per M.B.F. cut. At the rate of $4.00 per day the cost was $2.15 per M.B.F. There were several reasons for this high cost, among which were the unusually severe weather conditions, the objective of making a more thorough clean-up than is ordinarily required, and the haphazard logging which considerably hindered the work in this case. As shown farther on the cost of this method may be reduced to $1.19 per M.B.F. if it can be carried on free of some of the hindrances of the trial operation.

The factors tending to reduce the cost of this method as compared with that of piling and burning in two separate operations are:

1. A pile may be started in the most convenient place for the handling of the greatest amount of slash without much regard as to rotten wood, snags, reproduction or reserved trees.

2. A larger fire may be built and maintained with less danger of damage.

3. When the fire is well under way the slash may be thrown into the fire from a distance and without regard to the position in which it falls on the pile.

4. **Due to** the above factors each pile may serve a larger area, thus reducing a certain amount of lost motion; in the above case each pile cleaned up an area of 11 square rods.

The factors tending to increase the cost are:

1. The work is more or less disagreeable and at times will cause a rapid turn-over in labor.

2. Unsystematized logging operations cause the handling of slash which has become heavily covered with snow.

3. The time consumed in getting a fire well under way.

The practical question after making this trial is: What are the possibilities of reducing the cost of winter slash disposal so that it will be feasible in the western white pine type? The two main features of the work to be considered in this connection are the overcoming of the difficulties entailed in haphazard logging and in time lost in starting the fires. The loss of time due to unsystematic logging methods of the operator may be remedied by a clause in the timber sale agreement to the effect that the rear of a skidding trail should be skidded out first to enable the slash burners to follow on the heels of the skidding teams. The second difficulty may be overcome by the use of a powerful torch which will put a good fire under way in at least 30 minutes' time. The Hauck torch used at present was not found entirely satisfactory. With these difficulties remedied it should be possible to dispose of 3 piles per man per day, which at the above wage scale would cost $1.1 per M.B.F., a figure comparable to slash disposal costs under presen timber sale methods in the white pine type.

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No. 42 July 1923

PRELIMINARY RESULTS OF STUDY OF LIGHTNING IN RELATION TO FOREST FIRES

By H. T. Gisborne
Priest River Experiment Station

Lightning is the greatest single cause of forest fires in the Inland Empire. In the national forests included in Idaho, north of the Salmon River, there has been an average of approximately four lightning fires per 100,000 acres per year during the years 1911 to 1921 inclusive, or a total average of 40 lightning fires in each national forest per year.

The cost of suppressing lightning fires in District 1 of the Forest Service has averaged about $150,000 per year during the years 1920, 1921 and 1922, but it varies considerably from forest to forest and from year to year, according to the various conditions occurring at the time of each fire. The problem of reducing that cost by hastening detection, by increasing accessibility to all parts of the forests, and by improving fire fighting methods, is obviously one to be worked out by the protective organization on the ground. At the same time it is very evident that the occurrence and distribution of thunderstorms and their relation to the starting of fires constitute a distinct problem whose solution, or better understanding, would contribute greatly to a reduction in the cost of fire suppression. The Priest River Forest Experiment Station is consequently working on such a study with a view to a better understanding of the conditions which influence the formation and action of lightning storms, as well as the possibility of predicting these storms.

In this study, first consideration is being given to a determination of where the most storms occur, whether or not they follow definite paths with any regularity, the characteristics of the storms, and the relation of these characteristics to the starting of forest fires. Before commencing this study in 1922, it was known that the forests of northern Idaho experienced more lightning fires than the forests of Montana, but it was not known whether this was due to a greater number of storms, to a more dangerous type of storm, or to some other condition. Results of last year's work indicate that it is some other condition, perhaps timber type, which causes this difference. It was also thought that individual storms could be traced for considerable distances, and that if consistent storm paths could be found it might be possible to send out warnings ahead of these storms as soon as they had been observed in action. This condition was not found to occur during July and August, 1922. In fact the average storm was found to be very short-lived, to travel only a relatively short distance, and to travel in various directions in any one locality according to varying meteorological conditions. There is also a popular belief that the so-called "dry storm" is far more dangerous than the type accompanied by a longer duration of rainfall. During July and August, 1922, there was longer than average rainfall in the typical lightning storm which started fires, and less than average rainfall in the typical storm which did not start fires. Hence, it is evident that some of our former notions of lightning storms and forest fires may possibly change considerably as we accumulate more exact data on the subject.

In making this first canvass of lightning conditions in the forest regions of northern Idaho and western Montana the fire lookouts stationed on the higher peaks are being utilized to obtain reports on each storm visible. The final reports used last year were from 73 stations in northern Idaho and 73 in western Montana, a few, in each case, being from ranger stations rather than lookouts. From the location of these lookouts on the high mountain tops and their relation one to another, it is very probable that every lightning storm occurring during the periods of study is reported by one or more stations. The mass of reports is then assembled at the close of the season and compiled in such a way as to bring out as many as possible of the outstanding conditions observed. Some of the most important facts and conclusions resulting from last year's study are listed as follows:

1. This first intensive study of conditions showed that the forested region in District 1 experiences many more lightning storms than indicated by the data collected by the U.S. Weather Bureau at low elevation stations such as Lewiston, Spokane, Kalispell, Missoula, etc.

2. There were practically the same number of storm days in northern Idaho as in western Montana, yet there were four times as many lightning fires per 100,000 acres in northern Idaho, showing that number of storms is not alone a reliable criterion of danger.

3. During the 62 days studied there were 52 days with lightning storms in the District, and only 10 days without.

4. Of the 52 storm days there were only 6 days when high lightning danger actually prevailed. Two days, July 25 and Aug. 30,

stood out as the greatest peaks for the entire District. These peaks of danger should receive first attention in our attempts at forecasting. Messrs. Show and Kotok emphasize this fact in their recent bulletin.

5. Meteorological authorities recognize five rather distinct conditions which cause thunderstorms. The five types of storms are known as: cyclonic, tornadic, trough, border and heat storms. The first four types can be frequently forecast by the District Forecasters of the Weather Bureau. The heat type storms in the mountains can be forecast only on the basis of measurements and observations made right on the ground.

6. Local forecasts of a single heat type thunderstorm are usually of value for only a very restricted region, and the data obtained last year showed that there was no single storm day when an area as large as a single forest was wholly covered or affected by lightning. Most of the storms reported last year were apparently only four or five miles wide and travelled, as lightning storms, rarely over 50 or 60 miles.

7. Very frequently individual storms occur which have not been anticipated. In such cases it might be of value to be able to classify the storm as dangerous or non-dangerous as soon as it passes by, and before any fires have been observed. The results obtained last year indicate the possibility of such a classification, as shown in the next paragraph.

8. Storms with heavy lightning, over half of which was directed toward the ground, and with longer than average rainfall following the lightning, were the type which caused fires during July and August, 1922. Storms with light lightning, over half of which was confined to the clouds, with less than the average duration of rainfall following the lightning, were the type which did not start fires during the past season.

9. Last year's results indicate that it is the wetness of materials when struck, rather than the amount of rain following the lightning, which determines the probability of ignition. The same data also showed that the average lightning storm did not wet the fuels greatly before the lightning commenced. Consequently, following a very dry spell when materials are well dried out, a storm with many lightning strikes and also heavy rain may start more fires than a dry storm occurring when materials are wet before being struck. This may also explain why the timber types at high elevations, where high moisture contents are conserved throughout a season, are not subject to many lightning fires, although visited by numerous and severe lightning storms. A knowledge of the moisture content below which ignition can occur, combined with measurements of existing moisture contents, should tell us when and where to be prepared for lightning fires whenever storms can be forecast.

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No. 43 January 1 1924

NOTE

Owing to the press of work during the field season -- which extended well into November -- Applied Forestry Notes failed to make its appearance for five months. Partly to make up for this lapse in publication, the paper will be issued twice a month through the winter.

R. H. W.

THE RESULTS OF SOWING IN THE NORTHERN ROCKY MOUNTAIN REGION

By W. G. Wahlenberg
Priest River Experiment Station

Artificial reforestation in this region is now accomplished entirely by planting nursery grown seedlings or transplants. The question naturally arises whether it would not be simpler and cheaper to sow seed directly on the denuded lands, which it is desired to reforest. Why direct seeding is not feasible in this region is evident from several years of very thorough experimentation, the results of which have recently been compiled.

Following the large and destructive forest fires of 1910 the earnest desire to get new forest crops started led to extensive direct seeding projects. Altogether, 15,369 acres were sown either broadcast, in seed spots, or with corn planters and all important species, native to the region, were used. Practically all of this work was unsuccessful, for out of 343 trials only 20 r 6 per cent) succeeded. The establishment of at least 100 rees per acre was deemed necessary for success. Of 101 attempts to reforest by broadcasting, all failed except nine. Of 153 attempts to reforest by corn planter, all failed but nine. And of 89 trials of the seed spot method, all failed but two.

This early work was frequently poorly planned and not closely followed up. As a source of experimental evidence, therefore, too much reliance should not be placed on it. It was demonstrated, however, that under some conditions, direct seeding may be successful.

In view of this fact, a series of more intensive experiments was planned as part of the planting research work at Savenac Nursery. As studies at the Priest River Experiment Station had already shown that broadcast and corn planter seeding was, in general, undependable and too expensive, the work at Savenac was confined to sowing in prepared spots. Several variations in method were tried and seed of all the important species were used, including the native white pine, yellow pine, larch, Douglas fir and Engelmann spruce, as well as Norway spruce. Thirty tests, consisting of 300 spots each, were installed from 1916 to 1921. Accurate records of germination, loss by causes, and survival were kept, the plots being examined at 7 to 10 day intervals during the first two growing seasons and in the spring and fall of the third season.

On the whole, the results were very discouraging. Except for Douglas fir, the survival in all cases was less than 15 per cent, and even in the case of Douglas fir not more than 20 per cent of the spots in any trial now contain live seedlings. The existing seedlings, while approaching establishment, are still decreasing in numbers.

The failures are attributed to a large number of causes. The great abundance of rodents on the planting areas, chiefly the western chipmunk, wrought havoc with the seed spots which were not screened. The large seeds were taken in quantity, while the small seeds were not disturbed to any extent by animals. The application of a cover of litter to mask the seed spots proved ineffective.

After germination of the seed, drought was the most important factor in the loss of seedlings -- more deaths being attributed to drought than to any two other causes. During the dry summers, which are frequent in this region, the soil dries out completely to a depth greater than the roots of very young seedlings have been able to penetrate. A high evaporation rate, occurring at the same time, soon kills them. Cutworms were next in destructiveness. Fungi were not a large factor. Frost heaving caused many losses. There were also certain mechanical obstacles. Stones on or near the surface of seed spots hinder the deep penetration of the top root, which is necessary if the seedling is to survive the first summer season. Stones also become very hot in the sun and seriously injure the growing tissue of stems adjacent to them, in some cases perhaps accounting for death. The seed spots also fill in with the leaves of hardwood shrubs in some places and these, matted by the snow, thus form a mechanical barrier to germination.

It is likely that the success of restocking on certain areas, by broadcast seeding after the 1910 fires, was due to wholesale destruction of rodents by the fire, and a moist growing season following the seeding. On the Lolo National Forest one outstanding success is attributed by the ranger, in whose district the area is located, to (1) prompt sowing after the burn; (2) seed poisoned with red lead and the area strewn with poisoned oats; (3) favorable sites and (4) a moist season.

A small test of seeding in fresh ashes is now under way, but the major part of the experimental work on direct seeding has been closed. The only chance for success seems to be in man's ability to imitate the lavishness of Nature. Careful counts at the Priest River Experiment Station show that Nature, in order to obtain a stand of five thousand seedlings, sows seed of the large-seeded species at the rate of several hundred thousand, and of the smaller seeded species at the rate of several million per acre. It should be kept in mind, however, that Nature wastes more seed than the forester can afford to waste in his work, and that she is more patient with her many delays and failures than he can afford to be with his.

APPLIED FORESTRY NOTES

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District 1

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No. 44 February 1 1924

Note

The subject of a national forestry policy now before Congress and the public has many phases, one of which deals with provisions for leaving private forest lands in a state of continuous production after logging. The following contribution, which was presented as a paper at the annual meeting of the Western Forestry and Conservation Association in Seattle last December, contains the fundamental principles which underlie continuous production in the yellow pine type. Nominally it indicates what steps are practicable now in the absence of legislation. Some modification in the slash disposal requirements stated are contemplated for the greater fire danger encountered in Idaho and Montana as compared with Oregon and Washington.

R. H. W.

WHAT FORESTRY STEPS ARE PRACTICABLE IN LOGGING WESTERN YELLOW PINE IN THE NORTHWEST

By R. H. Weidman
Priest River Experiment Station.

With the neighboring Coast Douglas fir and Idaho white pine regions holding forth such encouraging prospects with regard to a second crop, it is rather difficult to show a favorable situation for the western yellow pine region, with its arid climatic conditions and slow forest growth. The yellow pine region, embracing as it does much of Oregon and Washington, as well as a portion of Idaho and Montana, is a big one, however, and its best land use is the growing of yellow pine timber. In view of this, it is important to consider what can be done to keep it growing timber, even though the practicability of the steps may not be so alluring as in other regions.

The fundamental object of forestry steps of any kind is to leave a logged area in a favorable condition for starting second crop of timber. Before we can intelligently discuss what forestry steps are practicable, it is necessary to indicate briefly what steps Nature follows in getting second growth and also what minimum forestry steps are necessary based on Nature's requirements.

Second growth in western yellow pine does not spring up as a crop of new seedlings immediately after logging, as in the case of Douglas fir and Idaho white pine. Nor is the seed stored in the ground. In the open yellow pine stands, seed germinates under the mature trees soon after it falls to the ground. This results in what is called advance reproduction or young growth on the ground before cutting. A cover of advance reproduction is not the result of one seed crop but the combined result of a number of years of seeding, germination and establishment of seedlings. There are several reasons for this long period of regeneration in yellow pine. One is that while this species bears a little seed from year to year, good seed years come only at intervals as great as 5 to 8 years. Another is that it furnishes a most attractive food for rodents, and because the forest is so pure over large areas, the meager annual seed crop is probably largely consumed by these rodents. The most important reason, however, is to be found in the severe drought and killing frosts which are a regular part of the summer climate of the yellow pine region. Thus even though successful germination following a good seed year may give rise to an adequately stocked cover of seedlings, severe frosts and drought in the first two or three years may cause so heavy a mortality among the tender seedlings that only a small proportion will survive. Under these difficult conditions of establishment it requires a number of years--sometimes as much as 20 or 25 years--for the seedlings which survive from year to year to make a cover of young growth satisfactory for starting a second crop after logging. Although the forest reproduces itself almost entirely by this slow method, advance reproduction is fairly abundant over most of the yellow pine region of the Northwest.

It must be kept clearly in mind that this advance reproduction is young growth which has developed thus slowly under the mature forest. It is already on the ground before logging, as an embryo second crop. Where it has been destroyed by fire or other cause a much longer period is required to establish the second crop following logging. The few seed trees that may be left standing are not as effective progenitors, in the face of the difficulties imposed by Nature, as the full stand of mature trees.

Advance reproduction, therefore, is the most important factor in forestry steps leading to a second crop. And the orces which tend to destroy it must be considered in formulating such forestry steps. A light ground fire in the virgin forest before cutting wipes it out. A broadcast slash fire after cutting not only destroys it, but destroys also the few seed trees that may be left. For the past ten years broadcast burning of yellow pine slash has been almost the universal practice on private cut-over land in this region. The result is devastation over the greater part of this cut-over land. This situation with regard to fire, in fact, furnishes the most urgent reason for the need of forestry steps in logging yellow pine.

Logging itself becomes a force unfavorable to advance young growth only when the methods employed are destructive or result in over-utilization. In recent years utilization in this region has come to the point of taking trees down to 10 inches in diameter on the stump. This means that no trees are left on the ground to insure a supply of seed in case fire destroys the young growth. Ordinarily horse and caterpillar logging methods and power logging using ground lines, when carefully executed, are not inimical to leaving the cut-over ground in good condition for a second crop. High lead and high speed methods of logging, however, are exceedingly destructive. They tear up a large part of the cut-over ground, destroy young growth and either break off or knock down the trees that should be left for seeding purposes.

In the southwestern United States sheep grazing is so detrimental to the starting of young growth that it must be suspended, on Government timber sales, for a number of years after cutting, in order to give the second crop a chance to become established. In our region, however, no special measures will be necessary other than the sort of regulated grazing any land owner should practice to keep his range continuously in good condition.

With this background it is possible to understand why certain minimum forestry measures are necessary to start and maintain a second crop. The following are these minimum steps:

1. With regard to slash disposal:

   Slash may be left lying on the ground provided that along roads, trails, railroads, and other lines and points of fire danger, it be piled and burned to a width of 100 feet each side of main lines of danger such as roads, and 50 feet each side of trails and at least 100 feet around camps.

   In addition, the cut-over area on which slash is left in this way should be divided into blocks of about 100 acres by strips 100 feet wide on which the slash should also be piled and burned.

   Snags should be felled on all strips on which slash is piled and burned.

Special fire patrol should be given the cut-over area until the slash is reduced to a condition of comparatively little fire danger. This will mean 10 to 12 years.

2. With regard to seed trees:

   At least four seed producing trees per acre should be left as an insurance against fire and for filling out under-stocked ground. In this region this will mean trees of not less than 17 inches in diameter, breast height. If no small trees of this sort are present, at least one large tree per acre should be left.

3. With regard to logging methods:

   Destructive power logging methods using high lead and high speed lines should not be allowed.

4. With regard to protection:

   The forest should be protected before, during, and after logging, in order primarily to preserve the advance reproduction. This means no broadcast burning in the virgin forest and no broadcast burning of slash after logging.

These are forestry measures which, to the best of our knowledge, are held to be the minimum necessary to start the second crop. They do not make up the most desirable forestry, by any means. That is found, perhaps, in the Forest Service practice, in which all the slash is piled and burned and as much as 20 per cent of the volume of the original stand is left on the ground. Although the private owner of yellow pine would not be justified at this time in practicing desirable forestry in so slow growing a forest as yellow pine, it may be to his interest in some cases to do better than is called for by the minimum steps. He might, for example, find it advantageous under some conditions to pile and burn his slash over most of the cut-over land. He might also find it to his advantage to leave all small trees under 12 or 13 inches in diameter, breast height. From a forestry standpoint such young trees should always be left, for they are at the period of their most rapid volume growth and to log them is to sacrifice the rapid increase they are making.

As the chief considerations with regard to what steps are practicable deal with costs, it will be well to indicate here the costs for the minimum steps. To pile and burn slash and fell snags on the indicated strips, and to give special fire patrol, to the remaining area on which slash is left, will cost about 15 cents per M board feet. To leave seed trees to the extent of 1 M feet of merchantable timber per acre, will cost 20 cents per M. These figures are based on an average cut of 15 M feet per acre and on costs of 35 cents a M for piling and burning, 10 cents a M for snag felling and 3 cents a M for special patrol for 10 years. The area on which slash should be piled and burned will vary from 15 to 25 per cent of the total cut-over area. As for the cost of protection, the figures for the Forest Service and the various protective associations are already available as an index. They vary from 1½ to 2½ cents per acre. Under forestry steps leading specifically to a second crop, this protection should be a little more intensive, and this would increase the cost to an average of probably 3 to 4 cents per acre.

Now as to what steps are practicable for the private operator at the present time. It is at this point that forestry and economic consideration collide. The subject from the operator's standpoint is necessarily one of dollars and cents. In the absence of tax reform and of legislative provision for fixing federal, state and private responsibility, the practicability of forestry steps is largely a matter of how far the broadminded owner can profitably carry out such steps. There is no question that it is profitable for him to give very good fire protection to his standing timber and equipment. To do that he must in most cases protect adjoining cut-over land. Protection of young growth on cut-over land, for its own sake, and the leaving of a few seed trees on such land, can be regarded as practicable, if it is recognized that a young second crop will have a greater market value than logged-off land which is burned and devastated. We are just now on the threshold of placing a value on cut-over land which is in a good condition with regard to a second crop. Moreover, it is a point to keep in mind that grazing rental will serve to cover a good share of the extra steps that may be feasible now. A year or two ago the grazing rental of 300,000 acres of private cut-over land in eastern Oregon averaged 12 cents an acre. Over much of the yellow pine country the grazing fees would probably cover the cost of all the forestry steps here proposed save that of leaving seed trees. It would seem, therefore, that the proposed slash disposal and protection steps, at least, are practicable right now.

APPLIED FORESTRY NOTES

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No. 45 March 1 1924

STIMULATING THE GROWTH OF ENGELMANN SPRUCE IN THE NURSERY

By W. G. Wahlenberg
Priest River Experiment Station

Engelmann spruce is generally recognized as a desirable forest tree for certain sites and localities. It has a rapid and unusually well-sustained growth, and produces a commercially valuable wood. Very good results in planting it on natural spruce sites are being secured in the District. Much planting in the spruce type still remains to be done and it is contemplated, also, to plant spruce to some extent on the burns in the larch-Douglas fir type. Under the existing methods of nursery culture, however, Engelmann spruce has one outstanding disadvantage as a tree for reforestation purposes. This is that growth takes place so slowly in the seed beds that except on the very best soil seedlings are not large enough for field planting until 5 years old and transplants are not large enough until 6 years old. This results in a greatly increased cost of planting stock, because of the long time seedlings occupy space in the nursery, as compared with 2 or 3 years required for growing planting stock of other species.

Knowing that the growth of Engelmann spruce seedlings could be stimulated by heavy watering and fertilizing, experiments were installed at Savenac Nursery in an effort to find a safe and effective method of securing more rapid growth and a consequent reduction in the period needed before the stock would be ready to plant. A soil analysis having already indicated that the nursery soil contained a sufficient amount of potash, the other two most essential plant nutrients, nitrogen and phosphorus were thought to be the important elements to add. Heavy watering and fertilizing tests were begun with a mixture of dried blood and bone meal in a ratio of 1 to 2. This fertilizer was applied at the rate of 3 pounds per 48 square feet of surface, for heavily fertilized plots, and at half this rate for lightly fertilized plots. The series of plots which was given heavy watering, received a total of 55.83 inches of water during three seasons, or 69 per cent more than normally watered beds, both rain and irrigation water included.

At the end of the first season all plants were small and no growth stimulation could be detected. One undesirable result appeared in fact, namely, an increase in germination losses caused evidently by the fertilization. In the series of plots that was given a normal amount of water, the survival for lightly fertilized plots was 42 per cent of survival on check plots, and for heavily fertilized plots it was only 25 per cent of the survival in check plots. Better results were obtained with heavy watering: for lightly fertilized plots the survival was 70 per cent of that in the check tests and for heavily fertilized plots, 53 per cent of the checks. It was thought that the germination losses were due to damping-off fungi which killed the seedlings before they appeared above the soil.

Dr. J. V. Hofmann, of the Wind River Forest Experiment Station, has observed that heavy nitrogenous fertilization makes the soil a better host for fungi and that neutral or only slightly acid or basic soils favor damping off. These conditions favoring the trouble were present. In writing about germination loss, Hartley° says "the radicles are killed very soon after the seeds sprout and before the seedlings can appear above the ground. This is an important type, which can be caused probably by any of the organisms commonly capable of causing the better known types of trouble." It has not been determined that these conditions were the actual cause of the difficulty experienced, but the trouble may be avoided as was shown by new sowing on fertilized soil the following year in which no such heavy losses occurred.

In spite of the germination losses, it was hoped that resulting stimulation might take place to more than compensate for the initial losses. Examination at the end of the second season gave indication of this result. In all cases watering, and especially fertilization, had resulted in greatly stimulated growth and increased vigor. Where heavily watered and fertilized, the seedlings were stocky, about twice as high, and had buds twice as large as seedlings grown in unfertilized beds.

Other examinations, made the next year, of two-year-old spruce on fertilized soil showed that dried blood and bone

° Hartley, Carl -- U.S.D. of A. Bul. No. 934 " Damping-off in Forest Nurseries," page 9.

meal in the (reverse) ratio, 2 to 1, produced similar results, and that the use of 15 pounds of sheep manure per 48 square feet even produced slightly greater stimulation than blood and bone. A test of complete fertilization by the use of wood ashes with the blood and bone failed because of heavy germination loss. Good growth in the surviving plants indicated that the same treatment in smaller amounts might be practical. ($\frac{1}{2}$ lb. blood, $1\frac{1}{2}$ lbs. bone, and 8 lbs. ashes were used per 48 sq. ft.). Although all fertilizers seem to increase loss to some extent, especially from fungus, the loss was not serious in most cases.

The development of three-year-old seedlings from the tests first mentioned in this paper was recently studied in the laboratory. The fertilized trees averaged more than twice as heavy and nearly twice as tall as those from the unfertilized soil of check plots, and they had a much more healthy color. The only inferior characteristics noted was in respect to the top-root (or transpiration-absorption) ratio. The percentage of total weight in the top was greater by 4 per cent in fertilized trees. Although good balance is essential, the difference here is not considered great enough to be significant by itself. In any event, the stock from these nursery tests is to be planted in the field, and our final judgment as to its merits must await the results in field growth and survival.

In brief, the results to date indicate that with fertilization 2-0 spruce can be transplanted and 3-0 can be field planted satisfactorily. If additional observations support this finding, it means a saving of one year over the best results obtained in the past or a saving of two years on the time needed to grow Engelmann spruce on the poorer soils of Savenac Nursery.

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No. 46 April 1 1924

MOISTURE CONTENT OF FUELS AS AN INDEX OF FIRE DANGER[°]

By H. T. Gisborne
Priest River Forest Experiment Station

Hofmann and Osborne, working on the forest fire problem in Oregon and Washington, have shown that many of the light weight fuels, such as moss on trees, the dead weeds in an old burn, etc., change moisture content, consequently inflammability, in close accordance with changes in atmospheric humidity. A measurement of the relative humidity of the air seems to serve as a usable index of prevailing inflammability of these materials, hence as a guide for the fire protective measures necessary at any time in those types where these light fuels are the chief carriers of fire. In the Appalachian region, McCarthy has found that the number of fires occurring each day increases in very close proportion as the vapor pressure of the atmosphere decreases. Bates, in Colorado, and Show and Kotok in California, have also found that daily measurements of the evaporating power of the air, as shown by atmometers or evaporimeters, are usable indices of the degree of prevailing fire danger; the higher the evaporation the greater the dryness of materials, consequently the greater the fire danger.

At the Priest River Forest Experiment Station in northern Idaho, we have been working along a slightly different line. Instead of trying to measure a single one, or all of the weather elements, and interpreting such measurements into moisture content of fuels and thence into degree of inflammability, we have been trying to perfect a method of measuring the moisture content of fuels directly and so

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[°] Paper presented at the annual meeting of the Western Forestry & Conservation Association at Seattle, Washington, December 13, 1923.

determine, without any excess interpretations, the degree of prevailing danger. Once this degree of existing danger is rather accurately determined for any type and site, it is then comparatively simple to forecast the changes to be expected according to the weather forecasts for the region as prepared by the U. S. Weather Bureau.

We know from experience that there is no great fire danger in northern Idaho unless the timbered areas are inflammable. If a fire in an old burn or slash area dies out when it reaches green timber, then danger has not reached the 1919 or conflagration stage. When the green timbered areas become inflammable, however, then the possibility of another 1919 increases directly as the dryness of these areas. It is our belief that if we can obtain accurate measurements of the dryness and inflammability of the timbered areas we will then be in a position to recognize and forecast the approach of extreme fire danger. This is our most important problem and we are consequently devoting the major part of our time to the white pine timber type.

Our second problem, that of measuring the degree of inflammability every day of the fire season in each distinct fire type, including old burns and slash areas, and predicting the degree of danger as far ahead as possible, is of extreme importance, because it is the object of good protection to reduce the loss and expense during the normal or subnormal seasons as well as during the exceptional year. We believe that the results obtained to date on our first problem will be of great value in solving our second one.

In our work at the Priest River Station we have departed from the customary course, and instead of attempting to determine what certain kinds of weather will do to the moisture content of the fuels, we are attempting to measure directly the condition of the fuels themselves. By this method we believe we can determine the degree of existing inflammability no matter whether it is controlled by rainfall, evaporation, humidity, or temperature, or all of them. All of the weather elements combine to influence the dryness of fuels and if we measure this degree of dryness and determine what that means in terms of inflammability, then we ought to know rather exactly where we stand in the line of danger.

During the last two fire seasons we have been measuring the amount of moisture in each of the important fuels on both north and south slopes at regular intervals throughout each season. On both slopes the top layer of duff has been found to be a little bit drier than the average of all the materials. Fine moss, the dead leaves of herbs and shrubs, and the smaller twigs are generally drier than the top quarter to half-inch layer of duff. The lower layer of duff, heavy branchwood and the outside wood of windfalls are generally wetter than the top layer duff. The condition of the top layer of duff is of further importance in that this material is the chief carrier of fire in the forest. Therefore, if we measure the moisture content in the top layer of duff and determine what this moisture content means in terms of inflammability, we should then be warned in sufficient time of approaching danger and be able to forecast the degree of danger according to reliable weather forecasts for our region.

During the past two fire seasons we have also made numerous tests of inflammability to determine how readily the top layer of duff would ignite according to different moisture contents. We have been able to delineate six degrees of inflammability on this basis. By plotting each day the amount of duff moisture on a chart with these six zones of inflammability shown, it is thus possible to watch the progression from no inflammability through very low, low, medium, high and extreme, or vice versa, according to prevailing conditions.

We all realize that no reliable forecast of fire danger can be made unless we know two things: first, prevailing inflammability, and second, the weather conditions to be expected. If materials are soaking wet to-day we may have very hot, dry weather to-morrow and the next day, yet no inflammability in the timber types. On the other hand, if materials are almost but not quite dry enough to burn to-day, then a hot, dry day to-morrow will almost surely cause high inflammability. It is easy to see from this why we must know, first, the degree of prevailing inflammability, and second, the weather conditions to be expected.

During the past season we received special telegraphic weather forecasts from the U. S. Weather Bureau every morning covering the next 36 hours in our region. As soon as we were able to measure prevailing dryness each day, we began using these measures and the weather predictions and preparing an inflammability forecast extending 24 hours ahead. These inflammability forecasts have been rated by the Chief of Forest Service Fire Protection in Montana and northern Idaho and he states that on an average of 78 days out of 100 our forecasts were very accurate. We believe we can raise this percentage considerably in future seasons.

The measurements of the amount of moisture in the duff were obtained with a new instrument, called a duff hygrometer, which was invented and developed/for this special purpose by the U. S. Forest Projects Laboratory and the Priest River Experiment Station. One of these instruments gave excellent results last year, but there are still several difficulties to be overcome before it will be recommended for general use. We will, of course, extend the system if possible to cover other types which dry out earlier in the season than the north slope white pine type, and so obtain warnings for those situations which are the first to cause trouble each spring.

We have, therefore, these facts for consideration. With weather and timber conditions similar to those of northern Idaho, the fire fighting organization is in great need of two sources of information; first, a measurement of existing dryness, and second, a forecast of future danger. If the measurements are made in the proper places and if reliable weather forecasts are obtainable, we should be able to supply both these sources of information and so recognize the approach of the exceptional season, as well as the fluctuation of danger during the normal years. With the duff hygrometer we are developing a method for making the desired measurements easily, cheaply, and accurately. Then by a combined use of the results of these measurements and the U. S. Weather Bureau forecasts for our region, we were able to forecast the degree of inflammability 24 hours ahead with satisfactory accuracy on an average of 78 days out of 100.

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No. 47 May 1 1924

YELLOW PINE SILVICULTURAL PRACTICE ON THE CUSTER NATIONAL FOREST[°]

By J. O. Thompson
Forest Ranger

Aside from fire prevention and suppression, perhaps no single Forest Service activity has a greater or more lasting bearing on the future of our forests than the selection of trees for removal under any of the various classes of timber sales.

On the Custer National Forest in eastern Montana, the marking problem is simplified by the fact that there is but a single commercial species, western yellow pine, The standard marking rules for yellow pine in District 1 are used with modifications whenever necessary to adapt them to local conditions. The yellow pine forest of southeastern Montana resembles that of the Black Hills in South Dakota and is, therefore, quite different from that of western Montana. These peculiar conditions and the intensive local demand for material make possible a very close utilization. Topography and growth offer but slight obstacles to logging. The natural tendency of western yellow pine to grow in even-aged stands in this region has been seriously disturbed on the Custer Forest by the ravages of fires which have occurred at irregular intervals of from 20 to 50 years, resulting in a wide range of age classes under some conditions.

Three silvicultural methods are used in marking on the Custer Forest. The shelterwood system is employed on south slopes and other areas wherever reproduction is not already well established. Clear cutting, with seed trees for fire insurance, is use

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[°] Excerpts from a paper presented by Mr. Thompson at a recent forest ranger meeting.

in mature timber on north slopes or wherever the reproduction is sufficiently dense and far enough advanced so as not to need the protection of the overstory. Selection is practiced where a wide range of ages exists. Combinations of these systems are employed in accordance with local conditions.

The silvicultural working plan for the Custer is based on a 150-year rotation. On the areas where selection cutting provides a reserved stand, a 30-year cutting cycle is to be followed. This rotation produces a tree of 19 inches d.b.h. in this region. The 30-year cutting cycle is made possible by a strong local demand for timber, and represents the assumed period necessary for seed trees to seed up an area and to protect the reproduction until it is able to care for itself.

In mature stands with good reproduction present and where there are not sufficient thrifty young seed trees, about one yellow-bark tree per acre is usually reserved on the true north slopes, three on the flats and rolling areas, and eight to ten on the south slopes. These trees are reserved principally as reserve seed supplies in case of fire destroying the present reproduction. If thrifty young trees above 10 inches d.b.h. are present, two of these per acre should be reserved on the north slopes, six on the flats, and fifteen on the dry south slopes, all yellow-bark or old trees being cut under such conditions. The influences of prevailing wind direction and topography on seed distribution must be considered in the selection of reserved trees.

On areas where numerous small sales are being made to various individuals, it is almost always found that each individual desires the best timber in the easiest location marked for his cutting. On the Custer Forest this difficulty is obviated by locating the sales on strips running at right angles to the topography, the strips being layed off to cover progressively the entire area. In this way each sale includes the various classes of timber and logging conditions from the choice and easily logged timber in the bottoms to the more scrubby and inaccessible trees on the ridges.

All brush is piled and burned either by the operator at his own expense or by the Forest Service, and financed from the co-operative brush disposal fund to which all purchasers contribute according to their stumpage cut. The piling and burning are usually done by logging operators or by crews hired for this express purpose by the ranger and paid out of the co-operative fund. In the latter case one good crew on the ground may cover the areas cut over under several different sales and operators.

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GROWTH AFTER CUTTING ON A WESTERN YELLOW PINE TIMBER SALE AREA IN MONTANA

By W. W. White
Forest Examiner

In the fall of 1923 a growth study was made of the Lick Creek sale area on the Bitterroot National Forest. The bulk of cutting was done in 1908, 1909, and 1910. A small beginning was made in 1907, and there was a light clean-up cut in 1911. The study is based upon the boring of 380 trees on the sale area and check borings upon 20 trees in a virgin stand similar and not far from Lick Creek.

For 357 yellow pine trees, average growth for 15-year period before cutting, .89 inches; 15-year period since cutting, 1.74 inches. There is no definite relation apparent between size of tree when released and subsequent diameter growth. For instance, the fastest average diameter growths since cutting occur as follows: Five 6-inch trees grew 2.19 inches; sixteen 24-inch trees grew 2.09 inches; and one 42-inch tree grew 1.90 inches, while the slowest growing diameter classes, omitting one 38-inch tree that is hopeless, are one 40-inch tree grew 1.15 inches, eight 28-inch trees grew 1.31 inches, and forty-seven 16-inch trees grew 1.34 inches in D.B.H.

Crown and opportunity classes.

Bull pine type of tree, either well released by cutting or by nature; ninety-four trees, growth 15-year period since cutting, 2.50 inches. Sizes of tree not a factor in diameter growth after release.

Good trees but not released by the cutting to any considerable extent; mostly bull pine in the interior of bull pine groups. Fifteen years' growth before cutting, .80 inches; fifteen years' growth after cutting, 1.06 inches. Growth response after cutting perceptibly better in smaller diameter classes. Forty-one trees in this group.

Good type of yellow barked trees, released either by cutti or by nature. One hundred thirty-six trees in this group. Fifteen years' growth before cutting, .81 inches; fifteen years after cutting, 1.81 inches. Diameter growth after cutting not related to size.

Poor trees to leave for future growth, smooth bark, flat, scraggly tops, a few defective. Some left for protection; some left by either mechanical or judgment mistake; and some have gone backward since cutting. Forty-two trees in this group. Growth fifteen years prior to cutting, .46 inches; fifteen years after cutting, .81 inches. There appears to be a definite decrease in both acceleration and periodic growth after cutting with the increase in diameter of the tree.

Trees that have been badly crowded or suppressed, released by the cutting, and are coming out in good shape. Forty-four trees in this group. Growth for 15-year period before cutting, .46 inches; fifteen years after cutting, 1.42 inches. In this group the 6, 8 and 10 inch diameter classes show the greatest acceleration and the biggest periodic diameter growth after cutting.

Area at B.H.

The trees now standing added to their breast height area on an acre basis for 5-year periods ending 1898, 169.75 square inches; 1909, 192.13; 1908. 198.31; 1913, 334.62; 1918 414.41; 1923, 444.49 square inches.

The average basal area of trees now standing was 5,954.36 square inches to the acre in 1908, and is now 7,147.88, an increase of 20 per cent 15 years after cutting.

Including trees lost since cutting, the amount left to the acre, expressed in square inches breast height, was about 6,500.

The following is diameter and periodic growth of the average tree now standing as determined from the average of all basal areas:

Date November	D.B.H.
1893	16.75 inches
1898	17.00 "
1903	17.30 "
1908	17.60 "
1913	18.10 "
1918	18.65 "
1923	19.25 "

The average sized tree cut, determined from basal area averages, was 22-inch D.B.H.

Breast height basal area cut per acre 10,984. Total basal area of original stand, approximately 17,435 square inches to the acre.

Volume feet B.M. Growth

Merchantable length of each tree estimated in field. By using merchantable length D.B.H. table, the individual tree D.B.H. tabulations and Terry's volume table for the Bitterroot, the volume was estimated. The trees now standing added 775 feet B.M. to their volume during the period 1893 to 1908, and 2,146 feet in volume to the acre in the 15 years since 1908. Annual rate of growth since cutting has been 143 feet.

Acceleration of growth occurred the very next season after cutting for yellow pine trees with good tops. The more suppressed trees took two or three years to get under way. Not nearly all the timber on Lick Creek had been cut the full 15-year period prior to this study. About 40 per cent may have been cut the full 15-year period or in time to increase its rate of growth. Thirty per cent had been cut 14 years, 20 per cent thirteen years, and 10 per cent twelve years. Increased growth then, due to the cutting, has only been possible for 90 per cent of the 15-year period upon which all calculations are based. This makes annual growth since cutting 158 board feet to the acre. Growth during the last five years is the best it has been at any time in the 15 years. At the present time growth is 160 feet B.M. to the acre. There is nothing to indicate any cessation of growth at all soon.

For the 15-year period before cutting, the growth on the trees now standing had been 51-2/3 feet B.M. per acre. The living trees were growing but some of them were constantly dropping out because of losses caused by fire, wind, insects, fungi, and mechanical accidents. Probably 25 to 100 years ago the net growth was nearly nothing. With organized fire protection beginning about 1900, there likely came again some net yearly growth.

Of the 380 trees studied, the highest increments have been added in the last 15 years, as follows:

100 - 200	ft. B.M. each	69 trees
200 - 300	" " "	23 "
300 - 400	" " "	11 "
400		3 "
		106 trees

These best trees were not confined to the plots with the lighter stands. Thirty-three of them came from plots averaging 40 to 75 trees to the acre at the present time.

Eighteen plots out of sixty show a volume growth since 1908 of 2,800 feet B.M. to the acre, and better. Thirteen of these plots average 40 or more trees to the acre, and only one has as few as 20 trees to the acre. Six of the plots show a yield of as much as 4,000 feet B.M. to the acre. These figures show the possibilities of yields when it is possible to leave plenty of good trees well spaced on good sites.

Miscellaneous observations.

The borings of 20 trees made in the virgin stand on Pierce Creek show an absolutely constant rate of growth for the last 30 years. So; for reasons of weather, there is no ground for doubting that the increased growth on Lick Creek was due to cutting.

Original stand....................	23,100 ft. per A.
Amount cut........................	15,600½ " " "
Amount left after cutting.........	7,500 " " "
Number trees over 6" d.b.h. left..	24.5 per acre
Amount blown down after cutting...	750 ft.per acre
Number trees blown down...........	2 per acre

It was noticed that the removal of one or more trees on the north seemed to have just as much effect on increased growth as where the removal was on the south. This was so pronounced that the conclusion is reached that root competition in yellow pine stands is fully as important a factor as light.

The distance that the removal of one tree will favorably affect others was not determined. One case was noted where the nearest stump or down tree was 150 feet away and yet there was a fair increased growth beginning the same year with other trees in the locality. It was noticed that small groups could be released by adjacent cutting without any internal thinning, but not to the same degree.

Any kind of a yellow pine tree released showed increased growth unless dying. One nice bull pine was found that had the top broken off at a height of about 24 feet in the logging operation. Three small base limbs not over 1½ inches in diameter and six feet long were left, and yet it had almost doubled a fair rate of diameter growth after release.

Conclusions.

1. The rate of diameter growth was a little more than doubled on all trees left after cutting.

2. The rate of volume growth trebled on all trees left after cutting.

3. The Lick Creek study includes the entire area of yellow pine type in that watershed, which should not be compared to studies made in more limited and strictly yellow pine areas. On the other hand, Lick Creek as a whole is better than the average yellow pine type in western Montana.

4. Loss from windfall has been serious but not overwhelming. Safe sites are well drained at all seasons. Previous exposure to winds adds to safety. There is much less danger on safe sites than was supposed at time of marking. Treatment of unsafe sites is still a problem and will vary from leaving more timber standing to none at all.

APPLIED FORESTRY NOTES

U. S. Forest Service
District 1

(Not for Publication)

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No. 49 July 1 1924

PRELIMINARY RESULTS OF THE WESTERN WHITE PINE YIELD STUDY

By R. H. Weidman, Director,
Priest River Experiment Station

One of the major projects of the Priest River Experiment Station, upon which Messrs. Larsen and Haig of the station staff have been engaged, is a yield study of western white pine in northern Idaho. The ultimate object is to supply a practicable measure for predicting yields per acre at various ages. This may be in the form of a normal yield table, an empirical yield table, or some other measure. One of the important features of the study is to formulate correction factors for the application of normal yield tables to actual stands.

Ten years ago a normal yield table was made for western white pine in this region. This yield table, however, has never proved of practical use, because of its extremely high values. In the case of Site I these values were shown as high as 135,000 board feet an acre at 150 years. The inordinately high yields of the original table were the result of selecting only the optimum stands and meandering the boundaries of the sample plots so as to include only the very best portions of these stands. Another contributory factor was the use of volume tables of much higher value than those now in use.

In the present study the sample plots are taken in stands neither visibly over nor understocked, the idea being to base the data on naturally fully stocked stands rather than on those of maximum stocking. The plots are not restricted to pure white pine, but are being taken in stands containing 40 per cent white pine and up. So far 34 sample plots, mostly two to four acres in size, have been laid out in stands 30 to 160 years old. These have been located chiefly on the Coeur d'Alene National Forest.

After checking over the mass of yield data of 10 years ago, it was found that some of the less extreme plots could be fitted satisfactorily into the series of the present study, making a total of 57 sample plots. Although more plots must be taken, the data from these have been assembled into a preliminary normal yield table for three sites. As the purpose of this table is chiefly to check the adequacy of the material to date, it is given here only in abbreviated form, and with the admonition that it be used with that fact in mind. The yields it contains are quite closely comparable to those resulting in average fully stocked stands in the light of timber sale experience in this region.

Preliminary Normal Yield Table

Western White Pine

Idaho

Age	Volume in board feet per acre		
	Site I	Site II	Site III
40	4,750	4,000	3,250
60	22,800	15,300	8,500
80	41,100	30,000	19,500
100	58,100	42,300	26,500
120	68,400	49,500	30,500
140	75,200	54,100	33,000

Curves of mean and current annual volume growth per acre based on the present plots, show that the greatest current growth in board feet is made at about 70 years and that the mean annual growth culminates at about 110 years. These figures are average for all sites.

The further work of the present study will be devoted both to securing more basic data and to investigating methods of applying normal yield to the prediction of yield in actual stands. One of the great difficulties of using yield tables has been that practicing foresters and timber land owners have generally attempted to use them without correction. Naturally this practice, for the most part, gives higher values than can be expected over wide areas. It may be pertinent to state parenthetically that these remarks apply also to the table given in this paper. Do not expect it without correction to show yields over extensive areas. A yield table, whether normal or empirical, is merely a standard of measure, from which actual stands may vary to a greater or less degree. This variation must first be ascertained by a preliminary examination in the field before the yield table can be used to predict the stand 30 or 40 years in the future, just as a preliminary cruise is necessary to determine the approximate volume of a stand about which we have no information whatever. In some cases an attempt is made to use a correction factor in the application of yield tables, but the conventional method in use is unfortunately not a thoroughly sound one. There is not time here to go into this subject other than to mention briefly that the basic thing involved here is the tendency toward normality, with increasing age, of young under or overstocked stands. It is the plan in the present study to investigate this subject thoroughly, and formulate, if possible, accurate correction factors for the application of normal yield tables in the western white pine type.

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No. 50 July 15 1924

NOTE

It is believed that the readers of Applied Forestry Notes will be interested to have the following resume of the white pine blister rust work in this region, prepared by Mr. Haig from various reports sent us by the Office of Blister Rust Control. It covers the work up to the beginning of the present field season.

R.H.W.

THE WORK OF BLISTER RUST CONTROL IN THE NORTHWEST

By I. T. Haig, Forest Assistant
Priest River Experiment Station

Members of the Office of Blister Rust Control, as well as the several Forest officers who visited infected bodies of western white pine in British Columbia a year ago have stated that it will be only a matter of a few years before the blister rust reaches the valuable white pine forests of northern Idaho. The field work of the Office of Blister Rust Control during the past year seems to bear out this assertion. Infected black currants were found east of the Cascade Mountains in Washington at several points in Okanogan and Ferry Counties, the nearest being about 70 miles from Idaho. In British Columbia, new points of infection were found, the nearest at Nelson, B. C., 35 miles from Idaho. Infected white pines have been found at Beaton, B. C., about 100 miles north of Idaho. At this point 14 trees were infected and nearby at Revelstoke, B. C., 41 trees were infected. In addition to these infections, the Canadian officials found one infected pine tree at Nakusp, B. C., which is about 85 miles north of the boundary line. It is believed that these infections are of recent origin and a natural spread from the heavy infection near Vancouver. The Dominion authorities are destroying all infected trees in eastern British Columbia as found.

The western branch of the Office of Blister Rust Control, in charge of S. N. Wyckoff, is now located at 624 Realty Building, Spokane, Washington. Last summer and fall this office had a number of field parties scouting and eradicating cultivated black currants. This currant is by far the most susceptible species of Ribes in the Northwest and is the most active agent in the long-distance spread of the disease. As a result of the field work, the following numbers of black currant bushes have been destroyed to date:

Idaho	413	plantings,	2,129	plants
Montana.........	309	"	1,879	"
Oregon..........	1,416	"	31,323	"
Washington......	5,739	"	82,689	"
Total	7,877	plantings,	118,020	plants

In addition to the work in scouting and eradication of black currants, quarantine inspection work has been carried on to prevent spread of the disease through nursery shipments. It is hoped in this way to delay the spread of the disease and utilize the time gained in developing and applying local control methods, and in studying the life history and habits of the disease under western conditions. In connection with this program a local control area was established in the demonstration forest of the Priest River Experiment Station. An area of 1,700 acres was cleared of currants and gooseberries at an average cost of $1.93 per acre. On other areas studied by the Office of Blister Rust Control the estimated cost of control ranges from $1.33 to $3.45 per acre.

Another activity in connection with combating the western white pine blister rust is the study of the life history and habits of the disease carried on by Dr. J. S. Boyce, who is the representative of the Office of Plant Pathology located at Portland, Oregon. The object of his studies is to discover the natural factors influencing the spread of the disease so the effectiveness of local control methods may be increased. One phase of this work deals with the susceptibility of various species of Ribes and the rate and distance of spread of each kind of spore. The English black currant has been found to be not only the most susceptible of our Ribes but also the one which is largely responsible for the long-distance spread of the disease. A study of climatic conditions has shown that dry seasons greatly retard the spread. But the most effective natural barrier, the dry belt extending north and south through Oregon, Washington and British Columbia east of the Cascades, has already been crossed at its narrowest point, as the infections in eastern Washington and parts of British Columbia prove. The western white pine seems to be more susceptible than the eastern white pine, and it is also subject to more severe injury. The disease does not spread from pine to pine, and a cleared area of 300 yards offers good control of the spread from Ribes to pine except where the black currant is present. From pine to Ribes, however, the maximum distance of spread is unknown. It is proved to be at least several miles and some investigators think, in at least two cases, that infections have taken place at distances of 150 miles. The fact that germinative spores have been caught in spore traps exposed by aviators at high altitudes lends considerable weight to this belief.

It is encouraging to know that the Office of Blister Rust Control has received a sufficient appropriation by Congress this year to carry on its work on an enlarged scale. One of the chief features of its work in the West this summer is a large eradication project near the international boundary in northern Idaho.

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No. 51 August 1 1924

REGARDING LIMIT OF VISIBILITY

By H. T. Gisborne, Assistant Silviculturist
Priest River Experiment Station

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It has been suggested that fire research might well devote some attention to the problem of visibility which is frequently a very important factor in reducing the efficiency of our lookouts in spotting forest fires. We know that there are usually periods each summer when we can not see very far because of certain conditions of the atmosphere. This obscurity is always due to the presence of various materials in the air which obstruct the passage of light rays and so cut down our limit of visibility. It is hardly probable that research will be able to find a way to see through these obstructing materials, or to remove them from the air, but that does not mean that there is no hope of improving the situation. In the not too distant future it may be possible to prevent most of this obscurity from occurring.

The following extract from an article on "Haze and Mist" by C. G. Simpson, F.R.S., taken from the January issue of the Scientific American, contains some interesting information on this subject:

"Perfectly pure air is almost completely transparent to visual light waves, and if the air were always pure we should see distant objects through air almost as clearly as through a vacuum. But the air is never pure; there are always more or less particles of foreign matter present. The action of the particles is twofold: first, they reduce the amount of light reaching the eye from distant objects; and, secondly, in the daytime they scatter the general light of the sky and so send to the eye extraneous light which reduces the contrast between distant light and dark objects on which visibility depends. Generally this foreign matter consists of a mixture of solid ponderable particles and hygroscopic molecules. [illegible] latter in perfectly dry air would be practically invisible , but when loaded with water in a humid atmosphere they add to the obscurity of the atmosphere.

"The amount of obscurity will, therefore, vary with the amount of solid matter and with the humidity of the air. Haze is due to this kind of obscurity, and varies in intensity from the slight obscurity of polar regions, which depends almost entirely on the hygroscopic particles, to the dense obscurity of a dust storm in tropical regions, which is due almost entirely to solid particles.

"When the temperature of air falls, the humidity increases until the saturation point is reached. The diameters of the hygroscopic particles grow, but even in saturated air, the amount of water extracted is not great, and if there is little solid matter present the obscurity is not marked. But if the temperature falls below the dew point the hygroscopic particles are sufficiently large to form excellent nuclei for condensation, and relatively large amounts of water are deposited for small falls of temperature. Real condensation has now commenced, and the obscurity changes from that of haze to that of mist. It has been a common practice to record atmospheric obscurity as haze when there is a noticeable difference between the readings of the wet and dry-bulb thermometers, and as mist when the readings are the same. This, however, is not a true criterion, for the air can be saturated without condensation while mist cannot be formed until water has been condensed on account of a fall of temperature after the dew point has been reached. The whole process of the formation of haze and mist is continuous, and in practice it is practically impossible to say when haze becomes mist, although extreme cases are easily distinguished. Nevertheless, haze and mist are fundamentally different, for haze owes its origin to foreign matter, and the small amount of water associated with hygroscopic nuclei, while mist is due to an actual precipitation of water from vapor to liquid."

From this information it appears that haze is largely caused by, or is, the presence of very finely divided particles of solid matter in the air, while mist is visible water vapor or liquid. Both tend to obstruct clear vision, but from our standpoint the effects are decidedly different in these two cases.

We know from every-day experience, and from experimental work all over the country, that when the air is very nearly saturated with water vapor the forest materials all tend to absorb some of this water and hence become wetter and less inflammable. Any atmospheric humidity high enough to interfere with limit of visibility is therefore welcomed because of its beneficial effects on the inflammability of forest fuels. Moreover, the effect of high humidity on limit of visibility is not very great, as shown by the following table of information obtained at Falkirk, England.

Mean Limit of Visibility in Miles

Depression of the wet bulb, degrees F.						
2	3	4	5	6	7	8
Visibility in Miles						
50	100	132	132	178	193	191

A depression of the wet bulb amounting to less than 2 degrees F. generally means a relative humidity of over 65 per cent in northern Idaho and Montana. Such a humidity usually prevails between the hours of 9 p.m. and 6 a.m. nearly every day, and at various other hours following rains, in our region. As shown by the above table such a humidity still permits fair visibility up to a distance of about 50 miles, which is sufficient for our lookout service.

Evidently it is not the mist, or high relative humidity, which we need to fear. Rather it is the haze of finely divided solid matter suspended in the air which puts our lookout system practically out of business at certain times. So far as we know this haze has two principal sources: dust storms, and smoke.

Dust storms are very troublesome in our region when high winds sweep across the desert country west of us and pick up tons of finely divided loess and silt which are carried hundreds of miles over the forest mountains. But these dust storms are both infrequent and short-lived.

Smoke, caused by the very fires which we are striving to eliminate, is undoubtedly the cause of most of our periods of low visibility. Smoke is largely composed of extremely fine particles of solid matter incompletely consumed by the fire and carried high into the air by the fires' own action. Legalized burning of brush during the dry season contributes a large part of this troublesome haze, while uncontrolled fires contribute the remainder.

It seems altogether probable that this hazy problem is one of those which will help solve itself. If the present practice of summer brush burning can be made illegal and prevented during the dry season, and if our fire control can be brought to satisfactory efficiency, the principal sources of haze will then be eliminated. Every advance step in the prevention and control of fires consequently will be an aid in itself to further detection and control. The thing is cumulative. Nature helps those that help themselves.

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No. 52 September 1 1924

NATURAL REPRODUCTION ON SINGLE AND DOUBLE BURNS IN NORTHERN IDAHO

By J. A. Larsen, Forest Examiner
Priest River Experiment Station

One of the active projects of the Experiment Station deals with a study of natural reproduction on the vast burned areas of northern Idaho. Last year the study was conducted in a burned area, close to 100,000 acres in size, located at the head of the Coeur d'Alene River. It is believed that the results of the study to date are worth recounting at this time.

Large fires burned in this locality in 1870, 1889, 1910, 1919, and 1923. Burns of all dates were studied except that of last year. Although some of the area was burned only once, most of it was swept by fire several times in the course of the last 50 years. The best single burns for study were those of 1910, and the best double burns, those of 1910 and 1919. It was the practice in the field to select for study those areas, which, if anything, had been burned over most severely. The forest of this locality was typical of the western white pine type, being composed of western white pine, western hemlock, white fir, western larch and Douglas fir.

In every instance where a single fire destroyed a forest, as in the case of the fires of 1870, 1889, and 1910, there has been a prompt and uniform restocking of the ground, in which white pine has made up a goodly proportion of the reproduction. There were no seed trees on these areas except for a few widely scattered larches and Douglas firs and some isolated groups of trees (often miles apart), which contained white fir and white pine in addition to the above species. A number of strips, 20 chains long or more, were run through various portions of the 1910 burn, upon which the number, age, and species of the seedlings were recorded. In the case where mature stands were destroyed by the 1910 fire, three such strips on northerly aspects showed 493, 265 and 132 seedlings per acre, with white pine comprising 44, 36 and 53 per cent, respectively, of the reproduction. In the case where the 1910 fire destroyed 40-year old stands (which had started after the 1870 fires), three strips on northerly aspects showed 1316, 535 and 280 seedlings per acre, with white pine making up 23, 35 and 50 per cent of the reproduction. On the drier, southerly aspects, one strip, on ground where the 1910 fire destroyed a mature stand, revealed 203 seedlings per acre, with 22 per cent of it white pine; and one strip where the 1910 fire killed a 40-year old stand showed only 58 seedlings per acre, of which but 16 per cent was white pine.

It is interesting now to see what the strips taken on double burns show. These were run on areas where the 1910 fire destroyed the original forest and the 1919 fire wiped out the reproduction which had become established since 1910. As the result of the two fires, there were naturally fewer surviving trees here than on the single burns. Now and then isolated larches were found and very rarely a small group of trees of the original forest. Two strips on northerly aspects showed 90 and 121 seedlings per acre, with 55 and 89 per cent larch, respectively. In one case there was no white pine and in the other only 2 per cent. Three strips on southerly aspects revealed 10, 14, and 50 seedlings per acre. The bulk of this was larch and white fir. Several strips gave nothing but very isolated seedlings, amounting to less than one per acre.

It is evident from these data that natural reproduction comes in fairly abundantly after single fires and only scantily, or not at all, after a second fire, more particularly where the second fire destroys a young stand before it begins producing seed effectively. In this connection, however, it is interesting to note that a 1910 fire which destroyed a 20-year old stand (which had started after the 1889 fires) was followed by 29 seedlings per acre, 16 per cent of which was white pine. This was on a high and somewhat favorable southerly aspect. Another fact evident from the data is that reproduction gets started with much greater difficulty, in the case of both single and double burns, on the south slopes as compared with the northerly slopes.

The data on age of seedlings on these burns yields some very interesting facts and deductions regarding the origin of the reproduction. Following a single fire, such as that of 1910, it was found that very few seedlings started in the first two years, that the greatest number started in the third, fourth, fifth, and some even in the sixth and seventh years, and that only a few started thereafter. Of all the reproduction on single burns, up to 80 per cent became established between the third and seventh years after the fire. This was particularly true of white pine reproduction. As the reproduction was too great in amount to have originated by long-range dispersion from seed trees, the evident deduction is that it arose from seed stored by rodents in the soil previous to the fire, or seed which fell from the trees following the fire. In any event, the fact that the bulk of the reproduction started several years after the fire is an indication that white pine seed remains viable in the ground up to at least six years after a fire. This is strengthened by actual records of controlled experiments. At Savenac Nursery and Priest River Experiment Station, for example, it was found that the bulk of the western white pine seed sowed in the spring did not germinate until one year later. At Priest River Experiment Station, western white pine seed was recovere from duff in a mature forest and placed in the greenhouse under conditions highly suitable for germination. The first germination occurred 18 months later. If certain white pine seeds germinate so slowly under the most favorable conditions, it is reasonable to suppose that it may require several years under unfavorable conditions in the field.

On a double burn, such as that in which the 1919 fire followed that of 1910, the very scant reproduction on the ground was found to have started during each of the four years elapsed since 1919. As the nearest seed tree (in all of the cases studied) was more than a half mile off, and the seedlings appeared widely and uniformly scattered, the obvious deduction is that exceedingly long-range seeding is in progress. From the figures resulting from this study, it appears that this restocking on severe double burns is taking place at a rate varying from less than 1 to about 10 seedlings per acre per year.

From the standpoint of practical application, these results of actual field study give verification to the observation that single burns in northern Idaho will restock sufficiently without artificial reforestation, except on very dry aspects where young stands were destroyed by the fire. Double burns, however, call for planting, unless we are willing to wait 40 or 50 years until the present widely scattered seedlings grow up and start offspring of their own. The results of the study would indicate that the south and west slopes should be the first to be planted, in order to get a forest cover established on these severe sites before they become too greatly deteriorated.

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No. 53 October 1924

OVERCOMING DELAYED GERMINATION IN THE NURSERY

By W. G. Wahlenberg, Forest Examiner
Priest River Experiment Station

One of the problems in producing western white pine stock economically at Savenac Nursery deals with delayed germination. This species, like other five-needle pines, has a strong tendency not to germinate all of its viable seed during the first season. With spring sowing the delayed, or second season, germination averages about 50 per cent, and is some times as high as 91 per cent, of the total number germinating. If two-year-old seedlings are being grown for field planting, this delayed germination results in an uneven-aged stand of 1-0 and 2-0 stock and necessitates culling the stock heavily, or else retaining it a year longer in the seed bed. Either practice is expensive and undesirable. Another disadvantage of spring sowing is that germination extends well into the growing season. This results in a large number of young and tender seedlings unable to survive, without protection, the hot days of July and August. Unless shade is provided, they die in large numbers from sun scorch and drought. Then in the fall these weak plants must be mulched to prevent frost injury, and this operation adds a further item of expense.

After experimental sowings at various dates in the spring failed to solve the problem, intensive experiments in fall sowing were initiated. These experiments extended over a period of six years. During this time over 100 samples of counted seed, or a total of 77,000 seeds, were sown and followed by periodic examinations through two years in the seed beds, and in some cases for several years after they were planted in the field. The final results showed that prompt and complete germination was secured the spring following fall sowing. In one case fall-sown plots had effected 83 per cent of their total germination before the end of May, while less than 14 per cent of the germination of spring-sown plots had been effected at that time. In another case germination from fall-sown plots was complete about 15 days before that of spring-sown plots had started. It was indicated that the first half of September, and possibly the last few days of August, was the optimum time to sow. Early sowing resulted in premature fall germinations which were lost over winter, and later sowing resulted in a marked decrease in total germination.

In fall sowing, therefore, prompt germination is secured, resulting in an even-aged stand and a lack of weaklings, due to late germination. Shading and mulching operations are unnecessary. Formerly, handling the shade frames was a considerable item, because they had to be removed and replaced several times a season for weeding operations. From the standpoint of shade frames and mulch alone, the saving of cost effected has amounted to nearly $250 a year at Savenac Nursery. This, together with the saving of one year in seed bed space and the saving of plants which would ordinarily become culls, is a matter of considerable importance in the operation of Savenac Nursery with its annual output of 3 million plants and its growing stock of 10 million plants.

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No. 54 November 1924

Note

Aside from the general interest of Mr. Flint's subject there is a timely value in it to Forest officers in this District who have to prepare the insect damage reports due in the District Office December 1.

VARIOUS ASPECTS OF THE INSECT PROBLEM IN THE LODGEPOLE PINE REGION

By H.R. Flint
District Forest Inspector

The data upon which this paper is chiefly based were secured in a brief field study made in several areas of insect-killed lodgepole pine in the vicinity of Monture Ranger Station on the Missoula National Forest. The purpose of the work was to secure more detailed information concerning the following phases of insect depredations:

1. Amount and character of the damage in typical stands of lodgepole pine.
2. Composition and character of the remaining stand.
3. Influence of the insect work on fire risk.
4. Probable future of this stand from a silvicultural standpoint.

Twenty or more chains of strip were run on each of three exposures; level bench at low altitude, (approximately 4100 feet above sea), steep northerly slope at approximately 5000 feet, and steep southerly slope at approximately 4500 to 5000 feet. All live and dead standing, or recently down, lodgepole and yellow pine trees, and all green trees of other species, 6 inches in diameter or larger were tallied by two-inch diameter classes, using the quarter-acre circular plot method. A six-inch diameter limit was chosen arbitrarily because it was apparent that but very few trees smaller than six inches d.b.h. had been attacked by insects. All live trees less than six inches d.b.h. and all reproduction and seedlings of all species were tallied by the mil-acre plot system, described by Lowdermilk in the August 1921 issue of Applied Forestry Notes. An increment borer was used on a number of trees to determine the age of the stands and to secure indications of the rate of growth.

From the best information available, it seems probable that the infestation in the vicinity of Monture Ranger Station first became of epidemic proportions about 1914, and that it had practically ceased on these particular areas by 1918. The epidemic appears to travel in a more or less progressive fashion over the lodgepole areas. Active work in a given tract apparently ceases when the most suitable host trees have been killed. The insects appear to choose moving to a new locality in preference to working on trees less than about six inches in diameter breast high. This belief is borne out by observations on a recent control project involving the treatment of about 500 lodgepole trees on the Helena National Forest. Of the infested trees on the Helena Forest, 79 per cent were in the dominant and codominant classes, and practically no trees six inches or less in diameter breast high were infested regardless of the fact that the stand was a dense even-aged one with many trees of small diameter. There is no evidence that the epidemic near Monture was checked by any agent of condition other than the exhaustion of the supply of suitable host trees.

The field work showed that approximately 72 per cent of all the lodgepole pine in the stand represented by the strips was killed by the work of the mountain pine beetle (Dendroctonus monticolae).

Before the insect attack, lodgepole made up 72 per cent of the trees 6 inches d.b.h. and larger, yellow pine 2 per cent, and other species 26 per cent. In the present stand lodgepole makes up 40 per cent of the green trees 6 inches d.b.h. and larger, yellow pine a trace, and other species 60 per cent. The other species -- Douglas fir, western larch, alpine fir and Engelmann spruce in the order named -- comprise a much larger proportion of the stand now than before the insect attack. In the uneven-aged stand now occupying the ground, however, lodgepole pine still predominates over any other single species, forming 40 per cent of the trees over 6 inches d.b.h. and 38 per cent of the young growth. Of the seedlings 5 years of age and younger, a strikingly large percentage is Douglas fir.

In the 200-year-old stand on the northerly slope, lodgepole is probably about to disappear as an important component, since it now comprises only 9 per cent of the green trees over 6 inches d.b.h. and only 2 per cent of the young growth. Many of the remaining green lodgepole trees are badly suppressed individuals of doubtful value as growing stock.

Most of the Douglas fir, spruce and larch in the stands 140 years or less of age are sufficiently young and vigorous to make a good growth in the future. Some of the individuals show accelerated growth since the thinning by insects. In the lodgepole trees of this and younger stands, accelerated growth was found in approximately 20 per cent of the trees bored.

It may be said that the stand is gradually passing over from lodgepole to Douglas fir as the predominating species -- probably a common and orderly occurrence in the plant succession of the region. Many years, perhaps a full rotation of 140 years or more, must pass before the stand again contains a volume of ? green timber equivalent to that which was on the ground just prior to the insect epidemic.

With regard to the susceptibility of the lodgepole tree or stand to insect attack, diameter rather than age seems to be the determining factor. Lodgepole trees are apparently attacked as freely in mixed as in pure stands. The remaining green lodgepole of this locality shows only a negligible amount of active insect work. As the epidemic has exhausted the host and passed on, control work here is unnecessary.

From the very abundant fire scars on all of the older lodgepole trees on the strips, the stand appears to have survived at least one surface fire in the last 70 years.

The intensity of any fire that may occur and the amount of labor necessary for its control have probably been practically doubled by the insect infestation. From the standpoint of fire protection, the falling dead timber during the next ten years will greatly increase the cost of trail and telephone maintenance in the insect-killed areas.

In connection with the fire risk caused by this insect infestation, it seems wholly impracticable, from the standpoint of costs and results, to reduce the fire danger on these areas by any method of removal of the inflammable material, unless some market for the dead material opens up in the next few years.

Should a fire occur on any of the areas examined, there are sufficient cone-bearing lodgepole pine trees to practically insure a stand of lodgepole reproduction following the fire. In such event, the present stand of lodgepole timber, which has no sale value, would be lost, but the ground would probably not become unproductive because a new crop of lodgepole would immediately begin to lay on wood. Keeping these points in mind, it is apparent that this area is a low liability.

Apparently, the dead trees begin to fall in considerable numbers through rotting off at the base about five years after they are killed. From about five years after killing the fall will probably be increasingly heavy for several years, and it will probably be twenty or more years after the trees are killed until practically all are down.

The control or prevention of destructive insect epidemics of this character in a stand of this kind is somewhat comparable to the control or prevention of fire in areas of low liability. In such cases in either fire or insect outbreaks, unlimited expenditures for suppression probably cannot be justified from any reasonable standpoint. If the outbreak can be taken vigorously in hand and controlled while it is very small, and cheaply controlled, action should, by all means, be undertaken. A similar policy has been in force in District 1 for several years with reference to fire suppression. (See page 101 of Instructions, Fire Protection, Northern District.) The case of fire differs from that of insects chiefly in that it often causes complete devastation and non-productiveness for many years, while insects merely destroy a part of the existing stand and increase the fire risk in it.

Control action on an insect attack, if successful, may well be expected to prolong the life of the existing stand from ten to fifty years, perhaps even longer, depending on the age of the stand at the time it was attacked. It is an expedient remedy for an existing ill. True correction of the ill probably lies in an economic or utilization situation which will make possible the use of all timber as soon as it becomes mature, or as soon as an insect epidemic manifests itself, even though the timber lacks a little of maturity. The insect damage differs from that of fire in that the young growth and the soil are untouched by insects.

The most practical course for the immediate future, in lodgepole stands, appears to lie in prompt detection and reporting of incipient isolated epidemics, followed by vigorous control measures while the epidemics are still small in scope. Detection and reporting can be handled by the present Forest forces. Control will depend chiefly upon the availability of an ample emergency fund similar to the present Fire fund.

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No. 55 December 1924

ACCELERATED GROWTH AFTER CUTTING IN WESTERN WHITE PINE

By I. T. Haig, Forest Assistant
Priest River Experiment Station

The question is often raised whether accelerated growth occurs, and to what extent it occurs, in trees that may be reserved after cutting in western white pine. This article contains some preliminary information on the subject yielded by a short increment study made on two old timber sales on the Coeur d'Alene National Forest last summer. One of the sales was in a mature stand containing a large number of trees under 14 inches d.b.h. (A-2 stands). The other was in a mature stand containing comparatively few trees under 14 inches d.b.h., but a considerable number of white pines above this size (B-1 stands).

The timber sale in the A-2 stand was cut 9 years ago. The marking was closely analogous to the practice now followed in A-2 stands under the present marking rules. The stand was even-aged, 120-130 years old. It averaged 251 trees per acre, of which 51 per cent were white pine and the remainder chiefly Douglas fir and larch. About 22 per cent of the total number of trees were removed in the cutting. The remaining stand contained 80 white pines per acre, of which only 9 were 14 inches d.b.h. and larger.

Increment cores from the white pine trees only were considered in this study. In the analysis the diameter growth after cutting was compared with that before, and this relation is shown for various classes of trees in Table 1. The relation is expressed as rate of increase; for example, 3.6 in the table means that trees in the diameter class 5 to 6 inches grew 3.6 times as fast after cutting as before. The degree of liberation shown refers to the per cent of crown circumference freed from competition by the removal of neighboring trees in logging.

Table 1

Relation of Diameter Growth after Cutting to that before Cutting (in white pine trees only)

Alex Lavoy Sale

By Diameter Classes		
D.b.h. Inches	Rate of Increase	Basis No. Trees
5-6	3.6	4
7-8	2.8	7
9-10	2.4	10
11-12	2.1	11
13-14	2.6	3

By Crown Classes		
Crown Class	Rate of Increase	Basis No. Trees
Suppressed	3.1	5
Intermediate	2.6	19
Co-dominant	2.2	11

By Health of Crowns		
Condition	Rate of Increase	Basis No. Trees
Fair	2.2	9
Good	2.7	26

By Degree of Liberation		
Per cent of Liberation	Rate of Increase	Basis No. Trees
25	1.4	1
50	2.4	6
75	2.5	20
100	2.9	8

Table II

Relation of Diameter Growth after Cutting to that before Cutting (in white pine trees only)

Ryrie-Wright Sale

By Diameter Classes

D.B.H. Inches	Rate of Increase		Basis	
	All white pines left	Healthy trees only	All white pines	Healthy trees
6-11	2.2	2.8	11	5
12-15	1.1	1.0	11	2
16 up	1.2	1.4	15	5

By Crown Classes

Crown Class	Rate of Increase		Basis	
	All white pines	Healthy trees only	All white pines	Healthy trees
Suppressed	1.9	3.4	7	2
Intermediate	1.8	1.9	9	5
Co-dominant	1.0	1.2	11	1
Dominant	1.4	1.5	10	4

By Degree of Liberation

Per cent of Liberation	Rate of Increase		Basis	
	All white pines	Healthy trees only	All white pines	Healthy trees
25	1.8	1.7	3	1
50	1.4	1.4	11	3
75	1.3	2.2	12	4
100	1.5	2.1	11	4

In general the increased growth of the trees on the first timber sale may be said to be good. Their health, vigor and windfirmness also appear to be satisfactory. The losses that may have occurred in the remaining stand, however, due to windfall, logging and brush burning are not known.

In the case of the second timber sale an excellent opportunity to study a partial cutting in a B-1 stand was afforded by a permanent sample plot established on an area cut 15 years ago. The stand was 120-140 years old and contained a total of 191 trees per acre with comparatively few small trees. About 50 per cent of the total number of trees were removed in logging, representing a volume cut of 65 per cent of the original stand. The remaining stand contained 55 white pines per acre, of which 28 were 14 inches d.b.h. and larger.

Table II shows for various classes of trees the relation of the diameter growth after cutting to that before. Because of the fact that there was an appreciably large number of injured and unhealthy trees on this area, the rate of increase is shown for the healthy individuals as well as for the total number of white pine trees in the remaining stand. The lower rate of increased growth here, and the inconsistencies in it,, as compared with the first area described are probably chiefly due to the great amount of injury in the trees on this area.

A fortunate feature of having a permanent sample plot on this area is that it is possible to study the loss as well as the increased growth. An examination 5 years after cutting showed that 25 per cent of the volume of reserved white pine trees was lost through death and windfall up to that time. The present examination 15 years after cutting shows this loss to have reached 46 per cent. The loss appears to be mostly in the larger trees. Furthermore, about 40 per cent of the remaining trees are now in a more or less injured and unhealthy condition. The losses other than windfall were apparently caused by logging and brush-burning damage. As this was one of the earliest timber Sales on the Coeur d'Alene National Forest, it is quite possible that the large amount of this damage was due to the lack of the present well developed technique in marking, logging supervision and brush disposal. Table III gives in detail the volume per acre reserved and lost on this area.

It is interesting in this connection to predict the yield of western white pine in this stand for the year 1940, 30 years after cutting. Assuming that the present rate of growth is maintained and no further losses occur, the volume of white pine will be 11,508 board feet per acre. As the white pine left at the time of logging amounted to 11,860 feet per acre, it is evident that the losses already have more than offset the increment that can be expected in 30 years.

Table III

Volume per acre Reserved and Lost -- Ryrie-Wright Sale

Including only trees 12 inches d.b.h. and up

Principal Species	Original Volume Bd. Ft.	Volume Cut		Volume Left		Volume of Trees Lost in First 15 years	
		Bd. Ft.	% of original	Bd. Ft.	% of original	Bd. Ft.	% of those left
W.W. Pine	30,380	18,520	61	11,860	39	5,445	46
Western Larch	3,730	2,350	63	1,380	37	140	10
Douglas Fir	3,400	3,400	100	none	none	none	none
Total	37,510	24,270	65	13,240	35	5,585	42

Although this is admittedly a preliminary study, its basis seems to be sufficient to warrant the conclusion that western white pine makes accelerated growth after partial cutting. The response appears to be relatively greater in the smaller trees and those of lower crown class than in the larger trees. Response is markedly less in trees that are slightly lacking in health and vigor. In general western white pine appears to be much less aggressive in responding to stimulation than western yellow pine. Acceleration begins usually two years after cutting and, in the healthy trees of this study, shows no sign of slowing up at 15 years--the age of the oldest area studied. Further study is necessary before accelerated growth can be predicted with any degree of accuracy and, in fact, before the value is ascertained of leaving large white pine trees in partial cutting with the object of securing accelerated volume growth.

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TEN YEARS' TRIAL OF SOME INTRODUCED SPECIES
AT PRIEST RIVER EXPERIMENT STATION

By R. H. Weidman, Director,
Priest River Forest Experiment Station

Tests of the growing abilities in northern Idaho of six tree species not native to this region were commenced at the Priest River Forest Experiment Station in 1912 to determine, if possible, the value of introducing such species. The results shown after ten years of growth may be of value to users of planting stock and to all those who are interested in the action of the white pine blister rust and its possible effect on North Idaho forestry. The information which follows is from the progress reports on this study prepared by J. A. Larsen, who was in nearly constant contact with progress of these tests.

Six species were used in this experimental planting: European larch, Norway spruce, Norway pine, Scotch pine, Austrian pine, and eastern white pine. Two sites, one comparatively dry and one more moist, were utilized near the experiment station at Priest River, Idaho. The area known as Benton Flat is a bench with a pronounced sandy loam soil which becomes dry during July and August. The Jurgens Flat area has a clay-loam soil with more available moisture than the Benton Flat site. Weather records at the Priest River Experiment Station show the following average distribution of precipitation throughout the spring and summer months: April, 2.37 inches; May, 2.27; June, 1.73; July, 1.13; August, 1.17; September, 1.89 inches. Under these conditions the following features of growth and survival have been found by the examination made ten years after planting.

European larch showed a survival of only 6 per cent, about 40 per cent of the loss being caused by gophers, however. The average height of the survivors was 75 inches. By comparison with a plantation of this same species near Moscow, Idaho, the conclusion was reached that better growth would have been shown if the Priest River test had been made on the moist rather than the dry site. The European larch apparently has no advantage over our native western larch.

Norway pine stock from the Minnesota National Forest showed 50 per cent survival and an average height of 34 inches on the dry site, with 5 per cent survival and a 50-inch height on the moist site. This species did not seem able to withstand the heavy, wet snows of northern Idaho. Many specimens which were seriously bent by the snow failed to straighten again. The very slow growth may be attributed to the lower precipitation at Priest River. St. Paul, Minnesota, shows, for instance, the following surpluses of rainfall compared to Priest River: May, 1.0 inch; June, 2.7"; July, 2.5"; August, 2.2"; September, 1.4". The normal relative humidity is also higher during the summer at St. Paul, near the source of this stock than at Priest River.

Eastern white pine seed, also obtained from Minnesota and grown in North Idaho, has failed to show very good results. Survival and height growth were both discouragingly low in the first plantations. A second planting in 1914 showed 80 per cent survival and an average height of 35.2 inches eight years later on the moist site. This species has suffered far more heavily from snow breakage than the native Idaho white pine. The Minnesota stock also appears to demand the greater rainfall of its native habitat. It is understood that experimental plantings of eastern white pine have been more successful in other parts of northern Idaho.

Austrian pine showed rapid loss and very poor growth for the first five years after field planting on the dry site. Ten years after planting, however, 41 per cent of the original trees were alive, with an average height of 28 inches, and their appearance seemed to be improving annually. The rainfall which these trees are receiving at Priest River differs from the Vienna records as follows: April, plus 0.72 inches; May, minus 0.25; June, minus 0.93; July, minus 1.43; August, minus 1.62; September, plus 0.11 inches. Evidently the species is more at home with greater summer precipitation.

Norway spruce has shown 33 per cent survival and 22 inches average height on the dry site, and 44 per cent survival with an average height of 61 inches on the moist site. The results indicat the desirability of more extensive experimental plantings in different parts of this region to determine more accurately the possibility of using this species for partially replacing white pine if the blister rust becomes really devastating.

Scotch pine has developed more vigorously than any species ever planted near the experiment station, native stock included. Although nearly half the specimens are very crooked, the remainder are of good form. This species is famous for its resistance to disease and consequently deserves careful consideration as a possible introduction to this region. Accurate survival and height figures cannot be given for the original plantation because two replantings of fail spots have since been made. Many of the trees are well over 90 inches in height. This species seems to thrive sufficiently well in Priest River climate to justify a trial in th lodgepole pine region where the weather may be even more favorable to its growth.

All of these results should be accepted merely as indicative of growth in this region for the first ten years' trial of these species. An exotic species cannot be pronounced as a desirable introduction for forest use until it has been followed throug a complete rotation and found to reproduce itself naturally or to produce a crop of viable seed.

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CHEMICAL WEED CONTROL AT THE SAVENAC NURSERY

By W. G. Wahlenberg, Forest Examiner

The Savenac Nursery, located in Western Montana, has an annual output of three million coniferous tree seedlings and transplants two to four years old. The care of seedbeds after the germination stage has cost about 40 cents per thousand trees by hand methods, and of this cost 16 cents, or 40 per cent, has been the cost of hand weeding. The culture of trees in transplant rows subsequent to the transplanting operation in the Nursery is more expensive, costing about $1.65 per thousand trees, and of this amount $1.15, or 70 per cent, has been the cost of hand weeding. Because of the close stands in which trees are grown in the seedbeds, often one hundred individuals per square foot of surface, there seemed to be no hope of reducing expense there through the use of any type of cultivator or mechanical device for weeding. The need at this Nursery has been the development of a more economical method of reducing or eliminating weed growth. Because physical methods held forth no promise, chemical means were tried, keeping in mind the possible injury to tree crops and the soil.

It is to be expected that the reaction of any chemical substance will vary with different soils, weeds, and crops, and that in other places the Savenac weed treatment may possibly require considerable modification before it can yield the best results. Therefore it seems desirable to make brief mention here of our working materials, the weeds, the crops, and the soil.

The three most troublesome weeds are species of sorrel, timothy, and clover. The principal means through which weed seeds are introduced are water, manure, mulch, wind, and sand. Many are received through the irrigation water. Various methods of filtering these out have been tried, but so far none have been satisfactory.

Of the annual Nursery-output of trees 85 per cent are stern white pine and western yellow pine. The remainder consists of Engelmann spruce, Douglas fir, western larch, and western red cedar. The chemical treatment of the soil has been thoroughly tested only with the first three of these tree species.

The soil, as reported upon by the U. S. Bureau of Soils in 1921, has good physical properties, a high percentage of granular structure, and highly oxidized soil minerals. There is a fair amount of organic matter, but much of it is not well-decomposed or the "humified" organic material may be a little lower than usual. There is no lime in the form of carbonate. Potash feldspars, potash micas, and lime-soda feldspars are present, but no phosphates or carbonates of calcium. There is a tendency toward acid reaction in the soil, the irrigation water being slightly acid.

Ten years ago various amounts of sulphuric acid were applied to plots of soil in the Nursery for the purpose of observing the effect on damping-off fungi. It was observed that in addition to its effect as a disinfectant, the acid had reduced weed growth. In 1916 preliminary tests of chemical weeding were started; in 1918 intensive study of the matter was taken up; and in 1921 a chemical method began to be relied upon on a large scale. It was preventing most of the normal weed growth.

The Savenac process is simple. Treatment consists in applying eight grams of zinc sulphate dissolved in 250 cc. of water to every square foot of seedbed area immediately after sowing the seed. This amounts to 1-1/8 ounces zinc sulphate per quart of water on every four square feet of seedbed.

Results from year to year have varied a little, but each trial has accomplished from 80 to 100 per cent reduction in the number of weeds present in the seedbeds for two seasons following the application. The treatment does not kill advance growth of weeds which may happen to be in the beds, nor pieces of roots or underground stems (runners) left from hand pulling, but it does prevent the germination of most of the weed seeds. They appear to be killed just after breaking their seed coats in an attempt to germinate. The treatment seems to be very fatal to clover seeds, quite effective on sorrel and timothy, and most of the native weed seeds fall an easy prey. In general the grasses have been observed to be least affected, and wheat seeds appear to be immune from injury or nearly so. One year after wheat straw had been used for mulch the previous fall, wheat seedlings were quite numerous on treated as well as on untreated soil.

The zinc sulphate (perhaps in the familiar role of a dilute poison) has a tendency to stimulate slightly the germination of pine seeds both in time and in total number of individuals sprouting. Careful comparisons of the behavior of stock from treated and untreated soil have been made during the various steps in nursery culture and subsequently for the first three years after field planting. The treatment has been found in no way detrimental to the subsequent development and survival of western white or western yellow pine stock. Engelmann spruce and Douglas fir germination is not injured by it, but the germination of western red cedar seems to be reduced -- probably because of the thin seed coats.

In the practical use of this process it is essential that care be exercised to secure an even distribution of the chemical. The experiments indicate that if, through any cause, as much as ten instead of eight grams be applied to the square foot, about seven per cent of the growing root tips of the trees will be injured and that this injury will steadily increase with the overdosage.

Since the zinc sulphate appeared to be quite deadly to most all of our native broad-leaved weeds, including the clover, it was expected that it would also be fatal to the use of field peas as a green fertilizer crop. On the contrary, however, tests indicate that not only was this assumption untrue, but that an unsuspected advantage was to be had. This was a marked stimulation of nodule development, and hence nitrogen fixation, by the peas grown on previously treated soil.

Most of the trials of this method of weeding at Savenac Nursery have been on the native soil in its natural state. A loss of effect on the weed seeds was noted when tests were made on flats of pure sand in the greenhouse, and in the Nursery on plots freshly fertilized with dried blood and ground bone or with sheep manure the treatment has been 17 to 18 per cent less effective. On sand the probable cause of lowered efficiency is too rapid leaching. On the fertilized soil the nature of the cause has not been determined, but the slight loss of efficiency perhaps can be reduced by plowing or otherwise working the fertilizers deeply into the root zone of the soil.

A disturbance of the soil such as that produced by pulling trees for planting seems to allow weeds to start on treated areas. Laboratory work by the Forest Products Laboratory at Madison, Wisconsin, has failed to reveal any trace of soluble zinc sulphate in our treated soil two years following the application, whereas small quantities of insoluble zinc were found both in treated soil and in the ashes of trees grown on such soil. Thus it appears that, through leaching from the soil and absorption by the trees, the soluble zinc has disappeared and new applications will be needed with each new crop of trees.

It is necessary to be cautious, however, for zinc is definitely recognized as a plant poison and there is possibility of damage to the soil from the cumulative effects of its repeated application. The Nursery soil seems to be naturally acid, and sulphur in various forms tends to produce acid soil. Because zinc sulphate is a salt of a weak base and a strong acid it is expected to increase soil acidity. So far at Savenac Nursery the weed-treated areas have not been noticeably more acid than untreated areas, but the natural reaction of the soil has made the use of lime necessary for the coming season. Independently of its neutralizing action on acids, lime is said to inhibit the toxic action of zinc on plants. Possibly further tests of the zinc sulphate in connection with the use of lime will be necessary.

For the present, based on the information at hand and the results of one small field test, it has been tentatively decided that when a second application of the treatment is needed on the same area, the amount of zinc sulphate originally used should be reduced by one-half, that is only four grams per square foot should be applied.

So far no attempt has been made to apply the treatment to transplant beds at Savenac Nursery. Because of the wider spacing of the trees, the cultivation of the soil, and the different method of irrigation, it may not be found practical for transplants. Yet from the seedbeds alone an annual saving in labor costs for hand weeding of about $353, or 32 cents per bed of 48 square feet, is reported. This figure does not include any estimate of the benefit derived from a method of weeding which does not disturb the roots of any tree seedlings. Mechanical damage from hand weeding in seedbeds during, or soon after, germination of the tree seeds is considerable. Hand extraction of the widespreading runners of the sorrel is still more destructive than the hand pulling of the bushy root systems of clover and the grasses.

It is to be hoped that the further use of this method at Savenac Nursery may not show any cumulative injury to the soil and that the method may be tested, modified if necessary, and applied at other nurseries.

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THE EFFECT OF WEATHER ON THE INFLAMMABILITY OF FOREST FIRE FUELS

By H. T. Gisborne, Associate Silviculturist
Priest River Forest Experiment Station

As the amount of moisture in forest fire fuels largely controls their inflammability, and as the weather controls the amount of moisture in the fuels, it should be possible to measure the weather and interpret the effect in terms of inflammability. Any accurate measurement of these conditions should be a better basis for determining existing and probable fire danger than a guess or estimate based on experience alone. Such measurements should also provide a common denominator for the comparison of reports of fire danger made by numerous men whose estimates may vary greatly because of the different experience or different bases on which they are made.

A series of measurements made at the Priest River Forest Experiment Station in northern Idaho, during the past three fire seasons, has shown that the top quarter to half-inch layer of duff (matted tree and brush leaves, twigs, etc., covering the mineral soil) is as a rule representative of the average moisture content of such other fuels as twigs, slash, dead branchwood, the full layer of duff, and the outside half-inch layer of wood on snags and windfalls. These are the principal materials which carry fire in this region. The top layer of duff is also in itself a very important fuel because of its widespread distribution and its proclivity to carry fire.

Very numerous tests have shown that the degree of inflammability of the top duff can be rated on the basis of its moisture content. While the duff in this region may contain as much as 400 pounds of water for every 100 pounds of material, it does not become inflammable until it has dried out to a condition in which there is less than 25 pounds of water in every 100 pounds of duff; in other words, until it has less than 25 per cent moisture content. The duff moisture contents can be divided into six zones of inflammability as follows:

Duff Moisture Content	Degree of Inflammability
Over 25%	Noninflammable
18% to 25%	Very low inflammability
13% to 18%	Low inflammability
10% to 13%	Medium "
7% to 10%	High "
Less than 7%	Extreme "

Under natural conditions with air temperature as high as 100°F and a relative humidity as low as 10 per cent, the duff will still have about 2 percent moisture content. Even with this water present, however, the material can be ignited all too easily, mere sparks being dangerous at such times. Experiments have shown that when the duff has over 7 per cent moisture content the danger from sparks is largely eliminated. At more than 13 per cent moisture content sparks, blazing matches, or glowing embers usually cease to become effective means of ignition and need not be guarded against. With more than 18 per cent moisture in the duff this material can rarely be ignited by small campfires or single slash piles burning upon it. At over 25 per cent moisture content the top duff will not, as a rule, carry fire from any source of ignition.

The measurements at Priest River show that these zones of danger, and the effects of these sources of ignition can be roughly determined by measuring a few of the weather elements which control the amount of moisture in the fuels.

Rain. RaiRain is most important in this region because it is the only element of the weather which has been found to supply enough moisture to dry fuels so that they become noninflammable. As a rule, any rainfall of 0.10 inches or more occurring in less than 24 hours will produce noninflammability in the top layer of duff at the end of the rainstorm. Long protracted, gentle rains have been found to be more fully absorbed by the fuels than rains of the same amount but of shorter duration. After the rain has ceased the fuels will dry out in accordance with the moisture content resulting from the rain, and the drying power of the air. The temperature and humidity of the air and the wind velocity control the drying power of the air.

Air Temperature. A comparison of very numerous simultaneous measurements of duff moisture content and air temperature show that temperature readings alone may be used with fair dependability to indicate the approximate inflammability of the duff, as follows:

Air Temperatures	Duff Inflammability
Less than 50°F	Generally safe
50° to 65°	Slightly dangerous
65° to 80°	Dangerous
Over 80°	Extremely dangerous

Relative Humidity: In a similar way it has been found that relative humidity measurements alone can be used for the same purpose to show about the same detail in this region.

Relative Humidities	Duff Inflammability
Over 75%	Generally safe
50% to 75%	Slightly dangerous
30% to 50%	Dangerous
Less than 30%	Extremely dangerous

Low temperature and low humidities can occur at the same time. In such cases a compromise condition must be estimated. At other times the fuels may be saturated with moisture as a result of a recent rain, yet a warm, dry wind may be blowing in from a region which has not received rain recently. In such cases the fuels may be much less inflammable than indicated by the temperature and humidity readings,,but they will be drying very rapidly toward equilibrium with the existing weather.

Wind. The velocity of the wind, is, of course, a very important factor in controlling rate of spread of fire. By leveling the flames so that more of their heat is effective in drying the fuels ahead of the main fire, high wind velocities often make fire spread through fuels which are too wet to burn easily with low or no wind. High wind also increases the rate of drying when temperature is high and humidity low by bringing a larger volume of dry air into contact with the fuels.

With measurements of temperature, and humidity, and good estimates of rainfall and wind velocity as a basis, it may be possible to state the degree of existing inflammability in much more detail and more consistently than it can be done on the basis of experience alone. With the dependable weather forecasts now available it may be possible also to prepare for the morrow with greater surety than without such information.

APPLIED FORESTRY NOTES

U. S. FOREST SERVICE
District 1

(Not for Publication)

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Devoted to disseminating the results of forest investigations applicable in Montana and northern Idaho. Address the Director, Priest River Experiment Station, Missoula, Montana.

No. 59 April 1925

FOREST SERVICE INVENTIONS BECOMING NUMEROUS

By H. T. Gisborne, Associate Silviculturist
Priest River Forest Experiment Station

The profession of forestry is not ordinarily considered as productive of inventive genius. A resume' of a few inventions by members of the U. S. Forest Service indicates, however, that in this business, as in others, "necessity is the mother of invention."

Some years ago it became evident that there was a great need for a small, portable telephone. The smallest and lightest-weight phone available at that time measured 3½"x7"x9" and weighed about 9½ pounds. R. B. Adams, telephone engineer in District 1, was assigned to the problem and the result is our present portable phone, measuring about 3"x3"x9" and weighing only 2 pounds.

About the same time there was a great need for an instrument for sighting on forest fires and obtaining readings more accurately than they can be made with a common compass. Forest Inspector W. B. Osborne of District 6 tackled this problem and the result is the now famous Osborne firefinder, recognized as the most successful instrument of its kind.

The instruments used for measuring the evaporating power of the air were not entirely satisfactory for many ecological and meteorological studies, so Silviculturist C. G. Bates, of the Fremont Experiment Station, invented the Bates evaporimeter, which is now being used extensively.

A method of making quick and accurate measurements of duff moisture content was needed in order to check our guesses of the degree of inflammability of the dead leaves and twigs composing the forest floor. Mr. M. E. Dunlap of the U. S. Forest Products Laboratory, assisted by the Priest River Experiment Station, therefore invented an instrument, called a duff hygrometer, which has been eloped so that both measurements and forecasts of inflammability were made successfully during the 1924 fire season in northern Idaho. There is a probability that this instrument may be adapted for measuring the amount of moisture in wood pulps, used in paper making, and so proving valuable to that industry.

Forest investigators frequently extract cores from living trees in order to measure the age, rate of growth, etc. of standing timber. There was no convenient and accurate method of measuring the width of the annual rings on these cores, and counting them, so Associate Silviculturist Duncan Dunning of District 5 invented an appliance to do these things.

Much hand labor and expense were required in building and maintaining trails in the forests. There was no satisfactory tool which employed horsepower for reducing manual labor, so Forest Inspector D. W. Beatty of District 1 invented one which, it appears from preliminary trials, may reduce the cost of trail construction as much as 40% to 80% and produce an excellent trail.

Firefighters in the Northwest need both a grub hoe and an axe while constructing fire lines. Forest Ranger Pulaski of District One found it inconvenient to carry both tools so he constructed a single tool having a head composed of both grub hoe and axe blade. Hundreds of these tools are now used in this region.

Communication over mountain telephone lines during the summer is very often impossible because of the noise of static electricity on the lines. Mr. R. B. Adams again stepped into the breach and devised a static filter to kill down the noise of the static, with an amplifier to build up the voice currents. Preliminary tests show this device to be very successful.

Foresters who measure the heights of standing trees with great accuracy, in order to compute the volume and growth of standing timber, were confronted with long and intricate mathematical computations in order to reduce their measurements to the desired result. Modifying a suggestion by Silviculturist Donald Bruce of the Washington Office, Mr. Haig, of the Priest River Experiment Station, constructed a slide rule which will do the complete computation in less than 20 seconds.

These few random examples of creative ability indicate that forestry is faced by many necessities, which are being overcome easily and rapidly. In all these cases the benefits have resulted from careful analyses of our present methods, followed by organized research into the possibilities of rectifying our weaknesses. Such is the action that spells progress.

APPLIED FORESTRY NOTES

U. S. Forest Service
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No. 60 May 1925

THE EFFECT OF SLASH DISPOSAL ON SUBSEQUENT REPRODUCTION

By I. T. Haig, Forest Assistant,
Northern Rocky Mountain Forest Experiment Station

Slash disposal after logging, as practiced in western white pine stands is so obviously a necessary step in the reduction of the fire hazard that little consideration has been given to the value of slash disposal as a silvicultural measure. It is apparent, however, that the removal of the heavy slash is highly desirable and beneficial from a silvicultural standpoint. The relative amounts of reproduction per acre, in relation to the amount of slash left after logging, are strikingly illustrated on one of the early cuttings on the Coeur d'Alene National Forest which was visited during the past field season in a methods-of-cutting study being carried out by the Experiment Station.

This area, cut in 1910, consisted of three parallel clear-cut strips with strips of seed trees between. The clear-cut strips are located at the foot of the slope on an east aspect in a mixed stand of western white pine, white fir, western hemlock, and western larch. Though all three of the areas are essentially the same in size, aspect, position on slope, and character and composition of the original stand, they differ radically in the amount of slash left after cutting. On one area the slash, scattered in rough piles or windrows as logged, has remained untouched by fire. The uncharred stumps, the absence of partially burned fragments of wood, and the presence of small twigs and branches on unrotted slash, give ample evidence of this fact. The second area was burned over rather lightly, as indicated by considerable debris which escaped the fire in some places. The burn on the third area was severe. The stumps and down timber are heavily charred and small branches and twigs are practically lacking. On both the second and third areas the slash was burned broadcast in rough piles or windrows. This cutting gives us therefore, a sharp contrast between areas on which slash has en unburned, lightly burned, and heavily burned, and on which the other factors influencing reproduction are practically equal. It ms reasonable, therefore, to suppose that any striking difference in the amount and character of subsequent reproduction would be due, at least in large measure, to the influence of slash left on the ground. In this connection, it is well to keep in mind that the slash resulting from heavy cutting in so dense a stand as that of western white pine is a great accumulation of debris which is quite different from the scanty slash following cutting in some other types, such as western yellow pine. The abundance of seed trees on this particular timber-sale area insured a satisfactory amount of reproduction in all cases and it is the relative rather than the total amount of reproduction per acre that is chiefly of interest. The amounts of reproduction found are set forth in the following table:

Restocking by Species	Number of Seedlings per Acre		
	Treatment of Slash		
	Unburned	Lightly burned	Heavily burned
Western White Pine	495	925	1775
Western Hemlock	215	2225	3750
Lowland White Fir	415	425	600
Western Larch	0	50	125
Miscellaneous	12	25	50
Total	1137	3650	6300

It appears, therefore, that slash left scattered on the area after logging materially reduces the amount of subsequent reproduction. In this instance, on the heavily burned area where little slash was left to interfere with germination and survival, the reproduction was over five times as heavy as that found on the unburned, slash-covered area. It is desired to point out here, however, that this broadcast burning evidently occurred under the most favorable conditions and that in any case broadcast burning is not compatible with good forestry practice, for the reason that it rarely results in a clean burn. The debris left creates a dangerous fire hazard, and in addition the reproduction is neither as heavy nor as desirable in composition as that obtained on areas where slash is piled and burned.

That the influence of slash on the amount of reproduction, as shown by the figures in this table, is not an isolated occurrence on this one sale area only, can be shown by an examination of figures taken by Larson and Lowdermilk on a large number of sale areas in the rse of their study of slash disposal in the western white pine e. These figures, taken from tabular summaries in Forest Service

Circular 292, "Slash Disposal in Western White Pine Forests in Idaho," are retabulated here in slightly different form to show the reproduction on unburned parts of areas where the slash has been removed by brush pilers and on unburned portions of other areas where the slash left on the ground escaped the fire. This tabulation is shown below:

Species	Number of Seedlings per Acre Unburned Surface	
	Brush Left on the Ground	Brush Removed and Piled
Western White Pine	784	1372
Western Red Cedar	151	165
Western Hemlock	536	3663
Lowland White Fir	403	235
Western Larch	108	202
Douglas Fir	131	11
Lodgepole Pine	52	183
Miscellaneous	26	0
Total	2191	5831

These data show that slash left after logging exerts a noticeable influence in reducing the amount of reproduction in the western white pine type. Although in this instance also the reproduction appears to be satisfactory in total amount under both conditions, the effect of the slash on the relative amount of reproduction indicates that its removal, though primarily a fire protection measure, is an excellent silvicultural measure as well.

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No. 61 June 1925

FIRE RESISTANCE OF NORTHERN ROCKY MOUNTAIN CONIFERS

By H. R. Flint, District Forest Inspector,
U. S. Forest Service.

Apparently very little has been done to determine the relative resistance of tree species to fire. However, the influence of fire on the forests of this region is so great that, as management becomes more and more intensive, we can ill afford to overlook any such vital characteristic as fire resistance in the species with which we deal.

Among the inherent characteristics which influence the fire resistance of the various species, the following are clearly apparent:

1. Thickness of bark
2. Root habit
3. Resin content of bark
4. Stand habit
5. Relative inflammability of foliage
6. Branching habit
7. Lichen growth

Perhaps there are other factors not so plainly apparent but these are the principal ones and some of them seem to be of relatively slight importance. Obviously the tree that is fire resistant in several of the habits or characteristics listed above has a great advantage over the one which is in several ways subject to injury.

Some intensive studies in Douglas fir fire problems on the Pacific Coast, conducted by Dr. J. V. Hofmann (1), clearly indicate the importance of bark thickness in protecting trees from the effects of surface fires. Doubtless it is the most important of all the factors mentioned above. The experiments show that "Douglas fir with bark four inches thick resisted, without injury to the growing tissue inside, a heat of 900° F. applied for four hours; and that slash fires heated the trunks from 880° F. to 1400° F. for periods of 5 to 20 minutes without harm. Trees 35 years old with bark $1\frac{1}{2}$ inches thick were killed after 52 minutes and 15-year-old trees with bark one-fourth inch thick were killed after 11 minutes in a heat of 900° F. Young trees 8 years old with bark 0.15-inch thick were killed in 1 minute and 10 seconds."

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(1) West Coast Lumberman, Vol. 46, No. 551, page 60.

A German investigator (2) reports that growing tissue (cambium) in trees is killed when heated to 54° C. (about 129°F.). Thus it appears that thickness of bark alone gives such trees as western larch, Douglas fir and western yellow pine a great advantage over many others.

Thickness of bark at the base of the tree varies greatly and to a considerable degree directly with the age of the tree. The bark of western yellow pine thickens very early in life, that of a Douglas fir is very thin in early youth and thickens moderately early. The bark of alpine fir thickens very slowly and never reaches great thickness. Thus most trees are poorly protected against fire in early youth, but some develop protection early in life and others very late, or to a very small degree only.

Many of our fires are surface fires or ground fires. This is particularly true of those that occur in other than the most dangerous times. In fires of this kind the tree with a deep or descending root system has a great advantage over one with a horizontal or surface root system. Here again, the western larch, western yellow pine, and Douglas fir, with their roots striking deeply into the mineral soil, have a distinct advantage over trees like the western red cedar and western hemlock with their roots spread horizontally just beneath a duff layer which frequently burns off with a considerable heat, leaving the shallow roots scorched and exposed in the top of a baked mineral soil.

The resin or pitch of coniferous trees is properly recognized as an inflammable material. Its presence in the outer bark of a tree greatly increases the susceptibility of the tree to damage by fire. The thick, corky bark at the base of old western larch, white fir, and Douglas fir trees bears but little resin and represents one extreme in this respect. At the other end of the scale is lodgepole pine and alpine fir, both with bark that even on the lower trunk may long retain its resin content. The age of the bark is an important factor in resin content. The young bark of Douglas fir or white fir usually bears numerous "blisters" or vesicles filled with resin. These dry out and the resin disappears as the bark becomes old, thus on the same individual the outer bark may be without resin at the base of the tree and very resinous on the new growth at the top. There also appears to be considerable individual variation in e resin content of the bark of trees of the same species and ge.

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(2) Heinrick Mayr, "Der Waldbau."

There appears to be at least a casual relationship between what is known to foresters as "tolerance," or some of the characteristics that go to make up tolerance, and fire resistance. Generally speaking, the intolerant trees of this region are highly fire-resistant and the tolerant ones are of low resistance. The branching habit of intolerant species like western larch, western yellow pine and lodgepole pine is open and the trees usually prune fairly well; therefore, there is but little fuel on the lower part of the trunk to overheat it or to carry fire aloft.

For the reason mentioned in the preceding paragraph, the lodgepole, with its roots entirely in mineral soil, with a minimum of fuel on the ground, and with an open stand habit not highly favorable to crown fires, has several important advantages over western white pine with its thicker and possibly slightly less resinous bark. The placing of lodgepole pine above western white pine in the scale of resistance, is, of course, debatable. Considering each tree in its typical stand, the lodgepole appears to be the better survivor. Growing in mixture with white pine on a white pine site, as it not infrequently does, the lodgepole, because of its thin bark, appears rather less resistant than western white pine.

Inflammability of foliage is an important factor concerning which there has been a great deal of discussion and apparently very little intensive investigation. Some preliminary studies at the Northern Rocky Mountain Experiment Station indicate that the moisture content of living coniferous leaves is very high, probably 100% to 300% of the weight of the oven-dry material. This is to be expected, because all living plant tissue is composed chiefly of water. Young leaves have been found to have a substantially higher moisture content than older ones, but it seems not to have been demonstrated that coniferous leaves contain substantially less moisture in mid-season during a dry than during a moist period. Although it may not have been demonstrated experimentally, it seems probable that leaves such as some of those on a fir tree, that have been on the tree for several years, contain considerably less moisture than those of the larch, which are never more than five months old. Possibly this is another factor in the high fire resistance of the larch.

A heavy growth of lichens, commonly called "moss" by woodsmen, is one of the features of the forests on the west slope of the Continental Divide in this region. Three lichens can be said to contribute materially to the fire danger. All of these are of the type known as "fruiticose," in reference to their anching or shrub-like form. Our two really important lichens are known as "black moss" or "squaw hair moss" and "green moss" or "gray moss." Botanically, the black one is "Alectoria fremontii" and the gray-green one is "Alectoria sarmentosa." They are common from the Flathead region in Montana through Idaho north of the Salmon River. They have been found on all of our common conifers and on a few of the larger shrubs. Neither species becomes abundant enough or large enough to be important from a fire standpoint in stands less than fifty years old. A peculiarity of both of these lichens is that they are very highly inflammable. During dry weather they may be lighted instantly with a match, whereupon they flame up quickly and burn with sufficient heat to ignite dead twigs and resinous green foliage. The lichens themselves appear to bear a resinous or oily principle which causes them to burn freely even in damp weather.

The present possibilities of practical application of this information are very limited. Under existing economic conditions, and with very limited silvicultural experience and skill with these species, it seems rather improbable that the forester can do much to favor fire-resistant species in timber-sale practice, or will desire to do so. Perhaps it may prove better business to eliminate the fires.

Table 1 lists the common commercial conifers in their order of apparent fire resistance and indicates the factors on which the order is based. There can be little doubt that western larch belongs at the top of a list made up in order of greatest fire resistance and alpine fir at the bottom. Many of the trees between the bottom and top of the list are assigned their relative positions arbitrarily and may be moved when research has yielded added information.

TABLE 1

SHOWING THE RELATIVE FIRE RESISTANCE OF THE MORE SILVICULTURALLY IMPORTANT NORTHERN ROCKY MOUNTAIN CONIFERS

SPECIES	Thickness of Bark Old Trees	Root Habit	Resin in Old Bark	Tolerance		Relative Inflammability of Foliage	Lichen Growth	Degree of Fire Resistance
				Branch Habit	Stand Habit			
Larix Occidentalis	Very thick	Deep	Very little	High and very open	Open	Low	Medium heavy	Most resistant
Pinus Ponderosa	Very thick	Deep	Abundant	Moderately high & open	Open	Medium	Medium to light	Very resistant
Pseudotsuga taxifolia	Very thick	Deep	Moderate	Moderately low and dense	Moderate to dense	High	Heavy to Medium	Very resistant
Abies grandis	Thick	Shallow	Very little	Low and dense	Dense	High	Heavy	Medium
Pinus contorta	Very thin	Deep	Abundant	Moderately high & open	Open	Medium	Light	Medium
Pinus monticola	Medium	Medium	Abundant	High and dense	Dense	Medium	Heavy	Medium
Thuya plicata	Thin	Shallow	Very little	Moderately low & dense	Dense	High	Heavy	Medium
Picea engelmanni	Thin	Shallow	Moderate	Low & dense	Dense	Medium	Heavy	Low
Tsuga mertensiana	Medium	Medium	Very little	Low & dense	Dense	High	Medium to heavy	Low
Tsuga heterophylla	Medium	Shallow	Very little	Low & dense	Dense	High	Heavy	Low
Abies lasiocarpa	Very thin	Shallow	Moderate	Very low and dense	Moderate to dense	High	Medium to heavy	Very low